ROYAL COMMISSION ON MATTERS OF HEALTH AND SAFETY

ARISING FROM THE USE OF ASBESTOS IN ONTARIO

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THE FURTHER PROCEEDINGS IN THIS INQUIRY RESUMED PURSUANT TO ADJOURNMENT

APPEARANCES AS HERETOFORE NOTED

GRAHAM WILLIAM GIBBS, PREVIOUSLY SWORN, RESUMES THE STAND

MR. LASKIN: I believe we are ready.

DR. DUPRE: Ladies and gentlemen, counsel, are you ready?

MR. LASKIN: I am ready, Mr. Chairman.

DR. DUPRE: May I Dr. Gibbs, welcome you back most warmly. I think our counsel will stipulate that you are already innoculated and therefore need not be sworn in again.

So will you proceed, please, counsel?

MR. LASKIN: Thank you, Mr. Chairman.

Just before we start, everyone will recall last time that Dr. Gibbs used a considerable number of slides in connection with his testimony. He has a few more today.

Linda Kahn has arranged with Dr. Gibbs to get the slides, and we will make photocopies and distribute them to everybody. We won't have them for about a week, so we will have to live without them for that period of time.

EXAMINATION-IN-CHIEF BY MR. LASKIN, CONTINUED

Q. Dr. Gibbs, I only have a few more areas that

Q. (cont'd.) I wanted to cover with you, having looked at and reviewed your testimony from last day, but I think it might help all of us here if you can very briefly just summarize the main points that you made last day, and perhaps you could spend just a little bit of time on the last topic that we discussed, which was fiber dimensions, mesothelioma and whatever relationship there may be between differences in fiber types and fiber dimensions, and so on.

A. Yes.

At my last presentation before the hearings, at the hearings, I touched upon the question of what workers were exposed to as being important in looking at the outcomes of asbestosis, lung cancer, mesothelioma and the question of other cancers, because it's possible that we are dealing, when we talk about mesothelioma or lung cancer and asbestosis, with possibly different etiological factors being responsible in different circumstances for each of these different diseases.

Now, let me clarify that. I think the example I used last time was that in lung cancer we have fairly good evidence that there seems to be some synergism, either additive or multiplicative effect, of smoking and asbestos exposure in the production of lung cancer.

When we look at mesothelioma, we don't see that effect, so we have something maybe different going on in the production of lung cancer than of mesothelioma.

We do not know for sure what are the factors that are responsible for each of these different types of disease, and because of that when we first started our Quebec asbestos mining studies we thought it important to look at some of the other factors that might be important - such as trace - metals, and I think the body of information that exists now suggests that trace metals can be a possible factor in the

THE WITNESS: (cont'd.) production of carcinomas, but in terms of looking at asbestos and their role in asbestos production of carcinomas, it's far from clear and I don't think that one would want to, at this point, say that trace metals would play any real major role in the production of cancer for asbestos-exposed workers.

We have to recognize that it's a complicating factor that people are not exposed to just pure chrysotile or crocidolite or amosite. They are exposed to other things as well.

When we looked at organic contamination, the evidence would seem to suggest that yes, asbestos fibers from mining through milling, into production areas, can contain organic constituents. But again, the concentrations and the nature and level of the other contaminants is such that they also are unlikely to play any real major role.

Whether or not they influence the behaviour of fibers in cells and so on is not known at this point in time.

The third factor about nature of exposure that I dealt with was the question of fiber dimensions. We do have a fair body of information which suggests that the health risks for people exposed to different fiber types are not all exactly the same, and one of the problems we do have is that we are lacking exposure data, in most instances, to be able to answer the question if we are exposed to the same concentration of crocidolite, chrysotile, amosite, what are the risks of getting a particular disease.

Nevertheless, the order of magnitude of some of the differences in health outcome are such that we must...we find it difficult to believe that level of exposure alone is responsible for the differences.

Examples I gave of this were the gas mask workers

THE WITNESS: (cont'd.) in Canada and the U.K., who have a very high rate of mesothelioma, and were working with Austrialian crocidolite.

The differences between the New York insulation workers and the Quebec chrysotile miners: Again both groups have been well studied and the Mount Sinai group with Irving Selikoff have also studied those groups.

We find, again, a large difference in the magnitude of the mesothelioma risk in those two groups. Maybe some of the other risks are not that different.

So the question of whether fiber type is important - the evidence that had accumulated over the years was that fiber dimensions are important from a number of standpoints. First, whether the fiber can get into the lung, secondly, whether once in the lung it is of such dimensions that it will produce a tumor more frequently because of its length and diameter than another fiber.

Evidence on this was produced a number of years ago by Stanton, that he implanted different fiber sizes on the pleurae and was able to demonstrate differences between the frequency of production of mesothelial tumors in those experimental animals, which were dependent upon the length and diameter of the fiber.

He did this with not asbestos fibers. He did it with aluminum silicate or glass fibers.

So we had some evidence that maybe the chemistry is not so important, but the dimensions are important.

What does this mean if we try to explain differences between occupational groups in terms of fiber dimension?

When we collect airborne fibers in crocidolite mining operations, in amosite mining operations, chrysotile

THE WITNESS: (cont'd.) mining operations, or milling operations, and we compare the dimensions, we find that we have differences in the length distribution and in the diameter distribution, and I showed the data last time to show that the sort of patterns of distributions of these three different fiber types are not identical.

So on the dimension, length/diameter, we can distinguish between the different fiber types.

When we come to look and see if the dimensions of different fiber types...or pardon me, within a fiber type... say, for example, chrysotile, are the dimensions of chrysotile the same in mining operations as they are in a milling operation, or the same in a textile operation, we run into a number of practical difficulties and the whole area is fraught with many practical difficulties, but we run into some very real practical difficulties because we know that for different processes, for different manufacturing products, we tend to use different fiber length or fiber grades as starting material, and starting materials may not come from exactly the same mine as we may have made our measurements on the dimensions in the mining operation.

So bearing in mind that we have that problem, nevertheless what appears to happen is this. The change in the dimensions, if you like, of airborne fibers in milling are not that much different from those in mining.

There is a tendency for the fibers to get a little bit longer, and there is some indication that there probably is some change, but the differences between, say mining and milling, are nowhere near as great as the differences between the different fiber types.

Now, as we move into textile area, it appears from the data that I do have for one textile plant that the variation between different operations in the textile plant

THE WITNESS: (cont'd.) are quite considerable.

Nevertheless, carding operations for example, we did, with very limited numbers of samples, tend to have somewhat longer fibers again than we counted in the mining and milling operation.

So for some reason, and it may be related to the choice of fiber that goes into these operations, all we can say is it looks like some tendency for the fiber, longer fiber, to get more selected later, with a tendency for the diameter to perhaps decrease a bit as we go down the process, so we may be ending up with slightly longer, slightly narrower fibers, possibly, in some operations down the way.

As far as crocidolite is concerned, there appear to be no major changes in its dimensions. There are some changes, but no major changes in dimension from mining through milling into the manufacturing process.

So in summary, there can be differences between different fiber types which are clear in distributions of fiber size. The changes with process are far less clear within a particular fiber type. But in general with chrysotile, there appears to be the tendency maybe for the fibers to be a little bit longer in the secondary stages.

The extent to which that is due to the choice of the fiber that goes into those processes really is not known at this point, and when we think about the number of measurements that have been made on fiber dimensions, they really are very, very limited because it's a very complex thing, a very costly and time-consuming job to measure the dimensions of each individual fiber and one is always stuck with relatively limited data.

The fact that with crocidolite we found virtually no change with process tends to give us some belief that there is

THE WITNESS: (cont'd.) not a major breaking apart of the fiber and there is not a major shortening, if you like, in the fiber.

Chrysotile is far more complex.

If we take the airborne size distributions of each of the fiber types, measured in mining and milling, and we apply them to the curves which Stanton produced, we find that each of the airborne dust clouds we looked at would have a very high probability of producing mesothelial tumors if the fibers were placed on the pleurae in experimental animals.

Now, this is where we run into the difficulty, the conflict if you like, between the epidemiological data and the experimental animal.

Here we have a situation where we know if we put crocidolite or amosite, and even anthophyllite where we have not seen any mesotheliomas in the Finnish miners, onto the pleurae of experimental animals, we produce mesothelioma.

MR. LASKIN: Q. Or chrysotile.

THE WITNESS: A. Or chrysotile, onto the lung, we produce mesothelioma.

But in the observations in man, we find quite large differences in the experience of the different occupational groups. So this means that there must probably be some other factors which play a role, and one of those factors I have no evidence to support, but I put up as a hypothesis last time - and it's not my hypothesis, other people have presented it before - that fiber durability or some measure of the ability of the fiber not to disperse, disappear, or whatever, might be an important factor in that. And there is some evidence to support that may be so, and I cited the break up of glass fibers observed by Kuschner and Wright as possible evidence that this durability might be an additional factor.

Q. Is there any evidence on that issue as it relates specifically to chrysotile?

A. I think it's not a question you can answer yes or no. I think that one could interpret some observations as possibly being compatible with this being a factor. The observation, for example, going back many years now when I believe it was Knox in the United Kingdom looked at the quantities of asbestos, total dust in the lungs of asbestos workers. He used optical microscopy and weight at the time, but he found that if people had been exposed, not exposed for quite a period of time, he was getting much lower weights of chrysotile in their lungs and it rather looked that maybe chrysotile disappeared in some way.

Now the argument always comes back, of course, did you ever know whether it got in there, and we don't know that answer.

Some of the studies that were undertaken at McGill by Allison McDonald, Neil Rowlands and myself were aimed originally at looking at whether or not fiber, chrysotile fibers remain in the lung after...for different period after ceasing exposure.

The problem with such studies is that you are having to look at autopsy material. Secondly, there are problems again, which you always ask yourself, whether or not the chrysotile originally got in.

If you classify people by high, low, medium exposure a long time in the past, and you look today, sometimes you don't find as much chrysotile as one would guess one would expect to find.

Is that because it dissolves? Is that because the fibers break apart and get dispersed? Is it because they didn't

THE WITNESS: (cont'd.) get in originally? I don't know.

But that's evidence...perhaps if one said well, yes, they got in and they have disappeared, that might be evidence that might perhaps be used to support that.

On the other hand, one could be devil's advocate on the other side and say, you don't need to find the fiber in the lung at autopsy to be able to say it was responsible for the production of the tumor twenty years ago.

Again, that's another argument that has been used, yet looking at the animal data together with the human data in parallel, it would rather look as if some other factor than just the straight dimensions is important, and it's possible as we go down the way that we may find there are many other interactions that are equally important.

The distribution of fiber size is obviously important, because if we just look at it on a probability thing, if we have a dust cloud which contains all of a very long, very short, very narrow fiber, then the probability of very long, very narror fibers getting to a site are quite clear.

DR. DUPRE: Dr. Gibbs, is a fiber-durability hypothesis necessarily a chemical hypothesis?

THE WITNESS: No, I don't think so. It could be a physical-strength hypothesis.

DR. DUPRE: Dr. Uffen?

DR. UFFEN: Could I ask a question about the size distribution? A few minutes ago you drew attention to the fact that as you go from mining to milling to textiles, the size may be different.

Does the distribution curve of number of particles of a given size, does the whole curve move, or does the shape of the distribution curve change? Do you follow me?

THE WITNESS: Yes.

I don't have the data with me to be able to answer that. The data do exist that one could put that together. We have a total length/diameter distribution for the samples that I have talked about.

I do have information which suggests that the... if one looked at length, for example, yes, there would be a shift to the right in terms of length, longer length.

DR. UFFEN: Longer length.

THE WITNESS: If one were to look at diameter, there would probably be a shift to the left a bit in narrower diameters.

Whether or not it's the longer fibers that are getting narrow diameters, or the shorter fibers, it becomes complex when you look at it three-dimensionally.

DR. UFFEN: Can you refresh my memory, if I'm supposed to remember, how you measured these? Were these done under scanning electron microscopes?

THE WITNESS: They were done by transmission electron microscopy.

DR. UFFEN: Can you refresh my memory, is this new information that we are now getting, or is it buried in the papers that we already have?

THE WITNESS: Okay. The mining and milling material is buried in the papers that you already have. The textile is not.

DR. UFFEN: Okay.

THE WITNESS: That's new information which I have not yet published. It's some information I have that is not yet published.

DR. UFFEN: Now, it would be pretty important from what you have just said in a gentle voice, can we have that information?

THE WITNESS: Yes, I would see no problem in providing a table with the...it's a question of what you want. I have a table which summarizes the proportion of fibers, if you like, within fixed...within greater than five microns, for example, greater than point five microns in diameter and greater than five microns in length.

DR. UFFEN: That would be very useful.

What about less than five microns?

THE WITNESS: And less than five.

DR. UFFEN: And less?

THE WITNESS: I'm sure I can find that.

DR. UFFEN: In other words, you can give us...

THE WITNESS: Yes. Well, we can give you the greater than five, we can give you the less than five.

DR. UFFEN: ...the whole thing? Not just part of it?

THE WITNESS: Okay.

The total distribution information I think, as I have not published it at this point, one thing I could do would be to approach the company that I originally did the measurements in the mill and ask them if they would have any objection to the total report being made available.

That's the simplest for me.

If they do, I can find the tables that would be appropriate to answer the question you asked.

DR. UFFEN: Can I ask just one more? Is this the only...are these the only data on the subject, or would there be other reference data that we ought to have?

THE WITNESS: No. There are some data...I don't know whether Dr. Dement has been to the hearings yet...there are some data under his name in the literature. I'm pretty sure it's from Dement.

DR. UFFEN: About the change...

THE WITNESS: Not on the change, but some dimensions in textile industry.

DR. UFFEN: The thing that I'm really interested in is your comment about the change in dimensions as you go from mining and milling to textile operations. This seems to me that this is new and significant.

THE WITNESS: Okay, let me clarify...make sure that we are clear on what was done.

My comment was that if one looks at the dimensional distribution, the length/diameter distribution, of fibers in the mining industry, compares them with airborne samples collected in the milling, and then compares them with airborne samples collected in the textiles, the tendency is for this to happen.

Nevertheless, we have no control over whether or not we are looking...we are certainly not looking at the same bag of asbestos fiber that went through the whole process, so whether it's a change in the dimensions of the fiber or whether it's related to the original source of the fiber that goes into those processes, I can't answer that question.

That's why I wanted to make it quite clear that... yes.

M. CASGRAIN: Could I have that answer again? I'm afraid I didn't understand.

THE WITNESS: Okay, sorry.

M. CASGRAIN: Could you go back, step back five feet or something?

THE WITNESS: Fine. What we did was to collect some airborne dust samples in mining operations, in milling operations and in textile operations, and we measured the size distributions of fibers in each of those operations.

THE WITNESS: (cont'd.) We had no control, though, over whether the fiber, for example we measured in the bagging area of the mill, say in the bagging area of the mill they were making a 3-T and a 4-D and a something-else grade. We would have no control over where...when we start in the carding operation, the textile plant, they may have started with three...a different...now because the original size selection for processes is largely on length, then we might start off with something which is not the same. So we can't argue that it's because the fibers break apart or because they shorten. All we can say is for those types of operations in these particular mines, mills and textile plants, that's what we found.

Is that clear? It's a limitation that one is stuck with, and I think it will only be a body of large numbers of observations that one would begin to get the pattern that would permit one to say well, this is more generalizable than the limited data suggests.

The other aspect I talked about before was the question of concentration. I showed you some concentrations in mines and mills and factories, and I indicated...and something that I will come back to later because I think it is very important...is the question of the control index...the fact that we use for control purposes the membrane filter method for measuring the airborne fiber concentration...and I believe last time some eyebrows were raised and some questions were asked in relation to a comment that we had made in a paper a number of years ago that midget impinger was the method, if you like, that should be used for control purposes.

Now the reason, I explained, was that we had data which showed that measurements of dustiness in the mining and milling industry, and we said nothing about...in fact we even cautioned against extrapolation into other industries...we

THE WITNESS: (cont'd.) said for the mining, chrysotile mining and milling industry in Quebec, we have good relationships between mortality and dustiness and measured by the midget impinger.

Now, I also indicated I don't believe the midget impinger is a very good instrument. It's not a good instrument for measuring fiber. It's not a good instrument even to measure dust under modern technology.

Nevertheless, we had an index of something which related to health effect. Then we introduced a fiber standard and we had very limited, if no, data which were originally based on the relationship between fiber concentration and health effect.

Now, as we think about what are we going to use for a control index, we've really got to bear that seriously in mind, because say, for example, we really had no way of checking whether or not fibers greater than five microns defined as three-to-one aspect ratio related to health effect, we could find ourselves fifteen years down the road measuring the wrong thing and having exactly the same health risks as we have today.

Now, let me give you an example of that. Say it really were...the fibers that were responsible really were the fibers that are not visible by optical microscopy, and we could record a zero concentration and still have a terrible cloud of this fiber in the workplace, and we could - fifteen years down the road - think we were under control, but not.

So it's very important that we look to see whether these things are related and that's the one logic, I guess, which convinces one to convert past impinger counts to membrane filter fiber counts.

As it so happens, it looks like the membrane filter counts do relate to health effects in the Quebec mining industry, as measured by mortality.

THE WITNESS: (cont'd.) So, yes, one might not have chosen a bad index in the sense that it looks like it's beginning to relate to health effects.

I think we ought to recognize that very rarely in any industrial setting do we know anything about, a lot or everything about the mechanism by which dust produces a health effect.

We can't identify, normally, that specific parameter that we should control in the environment and measure in the environment, with the knowledge that this is exactly what caused the effect.

Very rarely can we do that, so we have to choose some index. It doesn't matter whether that index is the whole or a part, as long as that index reflects the effect that we are trying to determine.

This is very relevant when we come to talk about transmission measurements and electron microscopic measurements later, because if the membrane filter count did not relate, then one would say we need to get the data to find something that does relate.

Now, for the Quebec asbestos mills we would have said, well, the midget impinger did. We would probably have serious problems down at this very low level end of the scale that we are working at the moment.

DR. UFFEN: Then that means to really use the membrane filter method we would be much more comfortable if we knew the size distribution of particles for individual operations where the membrane filter method is being used as the index?

THE WITNESS: Yes. This has been discussed within, for example, the International Asbestos Association, the industrial group which set up and did arrive at a standardized method approach for measurement of airborne fibers.

THE WITNESS: (cont'd.) That was discussed at some length on a number of occasions, and the general view, I think, among most scientists and among many of the industrial people was that they should try and set up a mechanism in the future whereby they know something about the airborne fibers in the operations - not only for the membrane filter count, but in terms of some of the dimensional distributions. Because if they add this body of information together down the way, they would have a substantial body of information as an industry.

As a routine though, it would be technically very difficult. The errors involved would be quite considerable probably, if you started to get all sorts of laboratories doing electron microscopy.

The cost of doing total size distributions by the present technology for measurement of fibers would be very, very costly.

So as a routine method of environmental control, if you like, if we took the Quebec mines I think I said there had been something like ten thousand measurements made in the 1970's, by membrane filter method.

Now, to do ten thousand electron microscopic counts at the moment I think, well, when I was at McGill we would have charged around two hundred, two hundred and fifty dollars a sample for EM count. You can imagine...

DR. UFFEN: But couldn't you do the expensive, time-consuming one once a year or once a month? In other words, periodically, in order to make sure that the fingerprint of that particular operation hadn't changed much, and then do your routine sampling every hour or day, or whatever, on the portion of the distribution curve,with some confidence that it hasn't changed?

THE WITNESS: That was, in essence, what the

THE WITNESS: (cont'd.) industry was talking about when we discussed it.

DR. UFFEN: Are they doing it?

THE WITNESS: No, at this point I don't know of anybody who is doing it, at this point. But I could be wrong. It's possible that they have, in some locations, done that.

But not as a whole. Not to my knowledge.

MR. LASKIN: Q. Can I just come back for one moment, before we leave it, to the discussion you had about fiber type and your one hypothesis you suggested for reconciling the apparent divergence between the animal evidence on mesothelioma and the human epidemiological evidence?

Can I ask you first of all whether you would suggest any other hypothesis, apart from durability?

THE WITNESS: A. There is the possibility, I suppose, that we have species difference. For example, that something happens in a mouse or rat, or something, and just doesn't happen in man.

I'm not sure whether that's tenable or not. I'm not an expert in that area to be able to say whether or not there would be such species difference.

All the conferences that I have attended, this has never been a serious consideration. The feeling has been that we have demonstrated this in the animal, we don't find it in man, there must be some other reason other than that rats behave differently than man.

But we know they do.

Q. Then can I come back to durability for a moment? If the evidence is that there is a difference in health effects as between chrysotile and the amphiboles in respect of mesothelioma, but there isn't that difference in respect of lung

Q. (cont'd.) cancer of indeed even asbestosis, why should durability be important in respect of the pleurae, but not important in respect of other parts of the lung?

A. I think, as I mentioned earlier, there are probably more...if we take the mesothelioma situation, the hypothesis probably by the mid-1960's was that length and diameter were of paramount importance in the production of mesothelial tumors, because you could demonstrate the probability of producing the tumors was related to the dimensions of fibers you put on the pleurae on the experimental animal.

No external factors were considered. When you come to deal with the lung cancer issue, we do know in man that smoking and other factors do play a role. So we are looking at a totally different mechanism, and there is nothing to say that the original site of deposition of the fibers, for example, it's unlikely...I can't think of any mechanism whereby the airborne fibers zip straight to the pleurae. They go in some way through the lungs.

So by an initial deposition site, you are going to have more fibers in the lung to start with. You are going to have more possibility of other factors playing a role than you would have on the pleurae, so I think yes, durability might play a bigger role on the pleurae than in the lungs simply by quantity, and secondly because of mechanism.

Q. Did your studies of the dimensions of airborne fibers lend any support one way or the other to the proposition that chrysotile fibers would have more difficulty in getting to the pleurae than amphibole fibers, that they would be intercepted on the way?

A. Well, of course, that was the one hope, I guess, at the outset, that one would be able to demonstrate the sort of curliness which Timbrell had suggested in his

A. (cont'd.) experimental work, and if one looks at the UICC samples that were used in the experimental work where he showed that the penetration into the animal's lung was low for chrysotile, his fibers were extremely curly.

When we looked at the airborne fibers that exist in the mines and mills, we found yes, there is some curliness and there are some branches in fibers and so on. But they really are nowhere near the same order of curliness as the Timbrell fibers were, and so our belief is, based on what we have seen, that it is not such a major factor as Timbrell has suggested.

It probably does reduce some penetration, but it certainly is not the major preventer of penetration.

DR. MUSTARD: This is an easily-tested hypothesis, at least comparatively speaking.

Has someone taken animals and had them inhale the fibers that you have been describing, and simply monitor the degree of penetration to the pleurae?

THE WITNESS: No. I think there are two technical reasons why it is more complicated.

DR. MUSTARD: I understand the complexity of biological work, but in essence, conceptually, it can be put down. So the answer is, it hasn't been done, which takes me to my next point.

It seems to me, therefore, that still had to remain as an equal hypothesis because there is no evidence against it, to the durability?

THE WITNESS: Yes. I think the experiment could be done by putting animals into the mill or into the mine or into the textile plant. From the standpoint of doing the experiment in a laboratory, there are...the technicalities are very, very difficult.

To put up a dust cloud that is identical to

THE WITNESS: (cont'd.) that in a mill is, I won't say an impossibility, but it's not easy to do.

DR. MUSTARD: The second point is, surely the durability one is equally easy to test. You set up animal experiments and you go to the criteria for it.

Has that been done?

THE WITNESS: There has been some work done by I think Wagner and Timbrell, where they did look at the lung. They sacrificed animals immediately after exposure and they found there was virtually no fiber, a very small amount of fiber getting into the lung.

But they were working with UICC fibers, so they immediately argued for the amphiboles, which are long and straight, they get into the lung, and for the curly fibers, they don't get into the lung.

That doesn't answer the durability question. It answers the penetration question with their experimental cloud.

Now, since that time there have been a number of studies that have been done with inhalation route, and the possibility exists that in the data that exist, one could get information on how long the chrysotile has remained...assuming that it has gone into the lung initially...and one would have to do a sort of Timbrell experiment to start with to demonstrate it really did get in or didn't get in to start with.

In other words...

DR. MUSTARD: But that hasn't been done?

THE WITNESS: I don't think it has been done systematically, no. I think there are...in the literature there are some studies where one could get some indication of what is going on, but I don't think that specific experiment has been done.

DR. MUSTARD: Okay, and there is a third hypothesis which probably has to be considered in the etiology of carcinogenesis. There has to be transformation of the cells that become malignant.

Some of the evidence which we have heard indicates that cells who like to eat things, called macrophages, interact with fibers.

It's also possible that that reaction is different for the different fiber types in terms of the mesothelioma story.

Do you know if there has been any work done on that aspect of a possibly hypothesis - the difference in the behaviour of the fiber in relation to the fundamental cellular interaction?

THE WITNESS: No, I don't know of any work that has been done specifically on that. Whether the fiber type, if you like, changes the type of chemistry that might go on in the macrophage interaction is what you are talking about, and I don't know of any studies that have specifically tackled that.

There is one thing that I do recall, and this is back in 1971, at a meeting in the United Kingdom on the biological response to fibers. Tony Allison at the MRC Mill Hill research laboratories produced a rather nice film on the way in which macrophages attacked fibers.

One of the things that George Wrigt, Dr. George Wright, at that point raised, which never really got followed up on, was that you would find some fibers in there which would be approximately the same dimensions as other fibers in there, where large numbers of macrophages would attempt to attack the fiber, and there would be other fibers which were not attacked at all.

The question came up, on a random basis one would expect each of the fibers to end up with one or two, but not for many to go for single fibers, and were there any differences between

THE WITNESS: (cont'd.) these fibers.

Allison wasn't able to answer the question, and nobody else, and I don't know whether...but this might, again, be another factor in this, even within a single fiber type, are there differences that occur between different fibers that might modify the interaction of the macrophage. I don't think we know the answer.

DR. MUSTARD: Let me just ask you a question about that. Actually for macrophages to interact with particles is a little process which goes on, which is well-described in George Bernard Shaw's Doctor's Dilemma, if any of you are interested in reading it, that the particles have to pick up proteins from the fluid in the body, and there are certain proteins which make...as I think George Shaw says in his play...butter up the bugs so the macrophages like to eat them.

Has anybody looked at the kind of proteins that are absorbed by these fibers in the body, and whether that influences the capacity of these cells to want to eat them?

THE WITNESS: I think the first part almost certainly has been examined, but I am not the right person to ask for the detail. No, no.

But certainly a lot of effort went into understanding the ferruginous body and the protein interaction, and more recently a fair amount of fairly sophisticated biochemistry has been done in that area. Whether or not the question about how that influences the macrophage ultimately, I don't know.

That's not a.....

MR. LASKIN: Good, okay.

THE WITNESS: The next area that I dealt with a little bit was a question of fiber conversion, and I think that we covered that fairly well, the limitations of the data in terms

THE WITNESS: (cont'd.) of making such conversions. The need to make them is very real, and I think one of the points that I made was that in terms of demonstrating dose-response relationships the data that existed in the past have served to show us that indeed the effects we are looking at are dose related.

That's a very important finding, because if they were not dose-related in some way, then any controls we try to put on we would have no reason to believe that in fact we were going to identify the problems.

So the fact we have identified some parameters which indicate dose response are important, and conversion is important in that to demonstrate that fibers also are so dose-related.

The other area I have touched upon last time was the question of fiber analysis in tissues, and the value of such analyses to give us some indication that certain people had been exposed to asbestos. I guess I cautioned against some of the problems with contamination that do exist, and I also raised the question of the unknown of the significance of tremolite in the mines of the Quebec chrysotile miners.

If one were going to cite evidence, perhaps a differential retention...and we come back again to this penetration question...one does find chrysotile in the lungs of chrysotile miners, but we also find tremolite. Sometimes we find more tremolite than we would expect to find.

Now, if one were to take the total dust exposures that some of these people will have had in the past, one would say if it were all accumulated in the lung, or even if the normal mechanisms of removal of the fiber which take place, one would still expect to find substantial amounts of chrysotile in the lung at autopsy.

But in fact sometimes you don't find a lot, but

THE WITNESS: (cont'd.) you do find these tremolite fibers which were virtually impossible to find in the bulk fiber, and it raises some possibility that has there been at some time some gross exposure to tremolite during the mining operations, and is that the reason for it, is it related to this childhood use of talc, soapstone, and so on. That is a problem.

DR. UFFEN: Now, the chrysotile and tremolite are chemically different, and the crystallography is different.

THE WITNESS: That's correct.

DR. UFFEN: Tremolite is...

THE WITNESS: It's an amphibole. Yes.

DR. UFFEN: An amphibole?

THE WITNESS: Yes.

DR. UFFEN: That brings us back to the possibility of a chemical explanation again, eh?

THE WITNESS: Well, it could be both. It could be physical in terms of the fiber originally getting there, and then after that it could be solubility or it could be just fiber breakup, which would be a physical phenomena. It could be a variety of other things. I don't know why it stays or why we find it as we do.

DR. UFFEN: We don't understand why there seems to be a great deal of evidence then that the serpentines and the amphiboles are quite different in this...?

THE WITNESS: I think that's...yes, I think if one looks at the Pooley data in the U.K. in the mesothelioma series and so on, the fact that the amphiboles are so commonly found in the mesothelioma cases, and chrysotile is found fairly equally, perhaps, in the control series, indicates in some way the amphiboles are behaving differently from the chrysotile in relation even to the health effect as well as into the lung.

THE WITNESS: (cont'd.) I don't think there is a reason to believe that they wouldn't. It seems to me that if one looks at the chemistry and mineralogy, they are totally different materials. We wouldn't expect lead to behave the same as mercury, or...

DR. UFFEN: Well, they are all silicates.

THE WITNESS: Yes.

DR. UFFEN: But if, it's just a little bit of a substitution, isn't it, of one element? I forget what it is, but we had the chemical formula...

THE WITNESS: That's right.

DR. UFFEN: ...there was iron and sodium in it, rather than...

THE WITNESS: That's right. It's a calcium-rich silicate, but each of the amphiboles has this big molecule, $Si_8O_{22}OH$ twice on the end, and the chrysotile is a much smaller molecule with a magnesium hydroxide outer layer, so we are dealing with quite chemically-different things. We are dealing with crystallographically-different things. They will have different properties, physical and chemical properties.

One, chrysotile, is readily leached with acid. Crocidolite and amosite are not.

You find, you know, the chemical reaction is different.

DR. UFFEN: Do we know very much, or anything at all, about the difference between the retention of tremolite and crocidolite, both of which are amphiboles?

THE WITNESS: I don't think we do. I don't think that experiment has been...it comes under the same category as chrysotile.

Okay. Now, what I would like to do now is to move on into just two or three other areas that I was going to

THE WITNESS: (cont'd.) touch upon.

One is the measurement of the airborne fiber concentration, and I was informed that some of the questions that are important for you relate to the sort of areas that one might see in measurements using the membrane filter technique.

As a starting point, maybe I can have the slides.

MR. LASKIN: The slides?

THE WITNESS: Yes, please.

As a starting point, the first question that we need to ask once we have made the decision that we are going to measure the asbestos fiber is, first, how do we identify that we are dealing with an asbestos fiber.

Well, let's move that back a step. How do we know we are dealing with a fiber?

Now, this presents a lot of very serious problems. It may seem very, very simple at first sight, but if we were, for example, to say anything which has a length three times its diameter is a fiber, as we look at it, if I showed you this like that, you would tell me that that's a fiber because what you are looking at is that.

If I show you it that way, you say well, it's like a plate. It's no longer a fiber. It's quite different.

The technical difficulty in defining what is a fiber - there is in the literature perhaps quite an elegant attempt to describe what is a fiber to Tibor Zoltie, where he deals with it from a mineralogists' standpoint and looks at structural requirements of the fiber, the fact that a fiber is different from a fragment in that it has tremendous tensile strength and all sorts of other physical properties that go along with it.

Now, when you want to look at a fiber to determine its concentration, those fibers in the air, you just do not have

THE WITNESS: (cont'd.) the technology and the ability to be able to pick each fiber and say, I can measure its tensile strength, it's a very single fiber, and I can be sure I am really dealing with a fiber.

Once I know I'm dealing with a fiber, if I want to say it's an asbestos fiber I've got to be able to do an analysis on it and I've got to be able to say that it really is this material.

Now, I can't just start doing an analysis on the fiber and therefore assume that it's asbestos, because if we took say a short, fat fiber of chrysotile - which we really knew was chrysotile - and then we took a cleavage fragment of, say serpentine, they would both give us the same chemistry because the host rock of chrysotile is serpentine, and the chemistry is the same.

If we took crocidolite, there is a nonfibrous variety called rebeickite, and rebeickite will occur with some of crocidolite, so we analyse both and we don't know whether we've got an asbestos fiber.

So I thought I should put into perspective some of the complexities that may exist if one wanted to go.

So what has been done from a practical standpoint? Well, there have been arguments over the years whether or not as a simple definition of what is a fiber - let's forget whether we are really going to misclassify some - let's say anything which has a length greater than three-to-one, or five-to-one, or ten-to-one length-to-breadth to ratio, would be considered a fiber.

The mineralogists would tend towards the longer end, and in the asbestos control area the decision was to use a three-to-one aspect ratio.

Now, this is probably done for a number of reasons.

THE WITNESS: (cont'd.) One, it was felt that with the limits of the optical microscope which were originally, when this definition first was used, using the optical microscope limits of visibility were thought to perhaps be around point five microns. That would mean...in fact, it's a bit less than that we know now, but that would give us one and a half micron fiber. Most people could probably see a one and a half micron fiber all right, therefore it's not a bad working tool.

It would mean that if you put in addition to that a five micron cutoff in terms of the fibers, the shortest fibers you were going to see, you would be looking at a fiber at the five micron end, taking a three-to-one, something which had a diameter around one and a half microns. Certainly at one and a half microns one really could see it. At one and a half to two microns, one really could see it.

So you had a practical method of looking at fibers.

There were some other reasons why a decision was made of a five micron cutoff. First, perhaps, and foremost in that consideration was the fact that macrophages in general tend to be quite successful at dealing with particles which are up to that size, and therefore it would be likely that if a fiber were going to be of biological importance it was going to be longer than that, and so that also would have been a factor probably in the five micron size cutoff.

Can I have the next slide, please?

What does the membrane filter method consist of? It consists of...sorry, it wasn't working.

The membrane filter method consists of drawing air through a filter. It's a membrane filter with usually a pore size of around...well, different pore sizes are used, but perhaps around point eight microns.

The efficiency of these filters for the collection

THE WITNESS: (cont'd.) of particles is very, very high because it's not...they are not straight holes through the filter. The air has to go a devious route through the filter, so the efficiency of collection of the fibers is very high.

The idea is that once you have collected the fibers on the filter and some fibers do penetrate into the filter a bit, you then collapse the filter or dissolve the filter to try and put the fibers essentially into one plane where you can make measurements of the....count the fibers on an optical microscope.

A lot of emphasis, in my view, has gone into the counting end of the problem, and perhaps not enough into the sampling end as well, because what you measure and ultimately conclude, it doesn't matter how accurately you can measure that final sample if in fact it wasn't collected as representative in any way, or representative of what you wanted to find out.

What I have put on this slide are a number of the studies that have been carried out using the membrane filter counting method, to see what sort of variation might occur from different counters.

Now, the membrane filter method, of course, becomes very important on an international scale. If we are going to answer some of these questions about different fiber types having different health risks associated with them for the same level of exposure, if we are going to be want to be able to confirm findings in one country using data from another country, we've got to have some sort of degree of agreement on what we are measuring and what we are counting.

Now, this is true from a legislative standpoint because if you introduce a membrane filter counting method in Ontario, which is quite different from that in Quebec or in the U.S. for example, where the same data have been used to derive that standard you in essence are not using the data to

THE WITNESS: (cont'd.) derive that standard.

Now, there is no reason why you shouldn't arrive at a different number. That's another decision. But if the technique is different, then you really are measuring something probably...can be something quite different.

So a lot of international effort went into this area and there was a study done on seven countries. Originally there were ten countries participating, and I think nine of them participated in an international counting trial, and I looked at seven countrys', individual countrys' results, and a copy of that paper is in the documents that were presented.

There was a Canadian asbestos counting trial and that information is in the document.

The international comparison of counts was a paper by Walton and Beckett, from the U.K., and that material has been published.

The ASTM counting trials, I don't believe have been published, but you may be interested in. I do not have copies of all their material. I have some of it in my files, but you may be interested in the trials that the ASTM...this is a Canadian committee on asbestos of which the secretary was Marcel Possett from the University of...from Sherbrooke, and they did carry out a number of counting trials, and you may be interested in their data.

They were particularly interested in whether or not there was any good reason to move from a three-to-one definition of a fiber to a five-to-one, or to a ten-to-one, because the arguments they made was that if you want to look at fibers on the optical microscope you can see longer fibers much more easily, and as you can see longer fibers much more easily, maybe you increase the degree of reliability of the counts by eliminating the counting of the shorter ones.

THE WITNESS: (cont'd.) Also, the tendency would be that fragments of rock which might be elongated fragments would tend usually to be short, and when you start looking for very long fibers then they are almost certainly asbestos fibers and not fragments of rock, so it would eliminate that possibility.

Can I have the next slide please?

Could I have the next one? That's the same.

Okay. Could I go back one?

MR. LASKIN: Go back?

THE WITNESS: Yes, please.

M. CASGRAIN: Is that it?

THE WITNESS: No, it's one before that.

That's it, I think.

What was rather interesting was that in the international trial that was carried out...and this trial was carried out by sending to different...each country was asked to provide some samples. The samples were then sent out to laboratories, to the main laboratory in each of those countries.

They carried out the count on a segment of the filter and each laboratory then sent to another laboratory the amounted sample.

So each laboratory got an amounted sample and a segment of a filter which they amounted themselves.

The interesting thing was that the ratio, the agreement between seven of the nine laboratories who participated was pretty good, and these laboratories had had no previous contact.

But we must recognize that these were very special laboratories. They were laboratories who did a fair amount of fiber counting and who were in international contact generally, so that their thinking might have been the same.

The ratio of the highest to the lowest count

THE WITNESS: (cont'd.) level, I think if we look at the international scale, was about two point eight to one. If we took all their samples overall, it was around two point eight to one.

The within-laboratory measurements, the repeatability on individual samples was quite good. The clearing methods were not good for some filters.

In other words, we found that there were filters coming from some locations where people were not able to clear the sample that we had accounted, properly. This is some problem with manufacture of filters or choice of filters in some places.

Also, there was a tendency that you got high counts when you used acetone clearing methods...higher counts than you got with the conventional...either NIOSH method at that time, or the British method.

There were some other interesting international comments as well. Laboratories which were used to counting, say anthophyllite fibers, weren't very happy at counting chrysotile fibers. They didn't like them.

The same was true of laboratories here when they encountered samples which they were not familiar with counting. People didn't quite know how to deal with these fibers which didn't have the same shape as the ones they normally counted.

Can I have the next slide, please?

Perhaps a rather interesting example of what happened here...is what happened here. In this case...these data come from South Africa...and there they had a laboratory which counted essentially crocidolite fibers. What they did, they gave, laboratory one mounted a sample after it had counted it, and gave it to laboratory two, and laboratory two counted it.

What you can see is that laboratory one counted about nine times as many fibers on sample number eighty-eight,

THE WITNESS: (cont'd.) and six times and eight times on the other samples, as did the other laboratory.

Even if you let the second laboratory do the mounting in this instance, and do the counting, again you went up to as high as fourteen times as many fibers counted by laboratory one.

Now, laboratory one just was not geared up to count chrysotile fibers, and when it saw chrysotile fibers on the thing, it tried to deal with them perhaps in the same way as crocidolite fibers and any bundles, it would count fibers as they overlapped one another and so on, and they had a lot of difficulty with it.

One of the things that has to be done if you are going to count different fiber types is the laboratory has to be trained and know how to deal with not only chrysotile, but crocidolite or amosite, or whatever, depending on what it is going to deal with.

DR. DUPRE: These are optical counts?

THE WITNESS: These are optical counts using the membrane...

DR. DUPRE: By fiber types?

THE WITNESS: That's right, by fiber types. These samples were collected from a chrysotile operation, were provided to a laboratory which normally counted crocidolite, and they found a lot of problems in being able to count chrysotile.

This isn't an isolated instance. It was one of the comments made on international scale. Laboratories complained bitterly about samples which they were not used to counting.

MR. LASKIN: Q. I'm not sure I understand what the figures signify.

THE WITNESS: A. These are the ratios of the

A. (cont'd.) counts by laboratory one to the counts by laboratory two. So if laboratory one counted ten fibers per c.c., and the second laboratory would have counted just over one fiber per c.c., the ratio of the two would have been nine to one.

Nine means laboratory one counted nine times as many fibers as laboratory two. Fourteen means they counted... would have recorded a concentration fourteen times as high as laboratory one.

Q. Was there some suggestion that the count of laboratory two was more-or-less accurate, or is this slide simply to demonstrate the variability between labs?

A. You cannot say which one is right. Maybe the one that was counting according to crocidolite rules, or whatever, normally, was right.

All we know, what we are talking about is the variability...that we could get two laboratories counting exactly the same sample and they would report concentrations which could be of that order of magnitude different.

DR. UFFEN: By a factor of thirty is much different.

THE WITNESS: That's right, that's right.

DR. UFFEN: In ninety-two, the top - seven point eight, the bottom - a quarter. So roughly a factor of thirty difference.

THE WITNESS: Yes, that's right.

DR. UFFEN: I hope nobody ever weighs me that way.

THE WITNESS: Now, this is a, I think, a special problem that has to be considered in counting - the training of people to know what they are counting. Because as you do that... can I have the next slide, please...in the U.K. they did do an experiment to see what would happen by training of people and

THE WITNESS: (cont'd.) by using experienced counters to have contact with laboratories, and you can see here, we are now talking about ratios between the different laboratories which are very much closer.

It's now believed internationally that if you do have regular contact between experienced counters and between counters, you can keep them pretty well in the same ballpark once you have defined the way in which you are going to count your samples, you are going to define a fiber, and so on.

MR. LASKIN: Q. Do you have any sense as to how good or bad the situation is in this country as amongst laboratories?

THE WITNESS: A. Well, can we come...we'll come to that.

Can I have the next slide, please?

Okay. These are the...I'm not sure I like the way of presenting this, but this is some work we did a few years ago in which the Department of National Health and Welfare provided a statistician to work with us on the variability across Canada in membrane filter fiber counts, and the little lines at the bottom that you see, for example under E and H, under K and L, from L right through to the other end here just off the screen, indicates the laboratories who would be not significantly different at the ninety-five percent confidence interval.

In other words, if we took Canada as a whole, taking these laboratories, and these laboratories range from some industrial laboratories, some governmental laboratories and some university laboratories, we would find that from L through to...I can't see the one off the scale...there would be...through to K, T, R I think it is there...those laboratories would have been agreed between them. The degree of difference in the samples that they looked at would have not made them different.

THE WITNESS: (cont'd.) On the other hand, on down at that other end below the K, we can find that we have laboratories who are perhaps not in agreement with the basic major group within the country.

Now, this doesn't mean that one is right and one is wrong. Nevertheless, we normally are looking for the consensus of opinion, if you like, around a concentration, and we tend to believe that if we get a large number of laboratories who do produce the same answer on the slide, essentially, that those who are outside those limits are not doing what we would expect of them.

In this particular instance, I think laboratory E really did not perform at all well. Their counts were around twenty percent - that's one-fifth - of the counts in the major group at the top.

So we do have some laboratories...did have some laboratories in Canada who did not perform at the same level as other laboratories, and even then there was a fair amount of variation even within the agreed group.

Is that answering...?

MR. LASKIN: Yes.

THE WITNESS: If we had a look to see how laboratories perform, that's taking our laboratories there and putting them on the international scale, what we did, we took the results of the international comparison involving the nine countries and in Canada, one of our laboratories - which I think was M - did count on the international scale.

So we looked to see how that...if our laboratory M corresponded at point nine four of the international count. Then how did the other laboratories in Canada stack up against that international count, and you can see that laboratory E was only point two four, which is way down...that's counting about a fifth of what other laboratories internationally were counting...

THE WITNESS: (cont'd.) about point four, point nine, and then up to some laboratories - Q and X, V - counting considerably more than the international laboratories were counting.

So this gives you an order of magnitude of the sort of differences that were existing between Canada, and internationally, and within Canada.

Can I have the next slide, please?

One of the problems that exists that has not been fully overcome, and I think there are ways of overcoming it, is this difficulty of carrying out a study to determine the degree of variability between laboratories. The moment some samples come in for a trial, then the chances are the technician is going to make sure that they do their best job on them.

So I suspect that what we are seeing up here in some of this variability is the best job, and not the normal job.

In other words, when somebody feels they are under test, if you like, and they know the results are going to be checked against something, they are going to take a little bit longer, they are going to be a little bit more careful.

One of the difficulties is in practical terms of doing such a trial. I think that looking down the way, one of the things that looks like it's going somewhere might be the availability of some international standard samples on slides, which then permit these to be slipped in now and again into the count and one can then see how the counter is performing in an ongoing way. I think that one needs that sort of quality control in the membrane filter fiber counting in the laboratory, because with time the technique, the technician changes a bit, and every now and again I think some way of keeping them, and some quality control, becomes important.

THE WITNESS: (cont'd.) That becomes important from the legislative, legal standard standpoint as well.

DR. UFFEN: Is it possible to do away with the human observer?

THE WITNESS: Okay..

DR. UFFEN: And have a procedure which, even if it's wrong, is always wrong by the same amount?

THE WITNESS: Yes, I...let me answer that 'maybe'.

It must be six or seven years, maybe more, ago when I heard that very, very shortly there would be a method of being able to do it, and since then a lot of effort has gone on.

In the U.K. there have been a number of developments - one very good one, and one which looked very, very possible, practical. The cost becomes very, very high, but one could forget about that if one is going to centralize the counting facility.

But they really have had tremendous difficulties in actually putting what is basically a simple idea into practical terms. The variability, if you take the chrysotile fiber in the different shapes - you've got a shape recognition problem - a lot of software has to be developed to get the machine to count the same thing.

One of the major problems has been the difference in density between...when I say difference in density, difference in optical density, perhaps, between the fiber and the filter behind.

I'm not using the right term, but in terms of visibility of the fiber on the filter or the fiber on the cleared filter, and if the fiber gets a little bit thinner, then the fiber when it's picked up by the detectors in the instrumentation that exists, tends to count the fiber as maybe five or six fibers with gaps between them.

THE WITNESS: (cont'd.) Now, you know when you look with the eye on the microscope, you are really dealing with one fiber. You don't want the machine doing that.

So a lot of sophisticated programming is being done to predict, based on the line in which the fibers occur, those bits occur, the probability that they indeed are joined up and therefore for the machine to count them as one.

That looks like it was progressing very, very well. I think it would be possible to buy such equipment. My advice to somebody would be that one would like to see a fair amount of data from such a machine and how it stacks up before jumping in with two or three hundred thousand dollars, which you may not understand exactly what you've got.

But, yes, that's the way things are moving and that's the answer.

DR. UFFEN: Where was this being done, in England?

THE WITNESS: Yes, it is being done in the United Kingdom. I think it was probably Marc Trudeau who would almost certainly have mentioned that, I suspect, during the hearings.

He went to the U.K. to see that instrumentation a couple of years ago, in Manchester I believe. I have not seen the particular equipment, but I have met and discussed with some of the people involved in the development, and it really was looking very, very good, and a number of samples had been provided to them to permit them to see how well it counted fibers from different places.

So yes, that's the way it will go and that, I think, is the ultimate solution, is to eliminate the observer.

Can I have the next, please?

One of the developments which was very important

THE WITNESS: (cont'd.) and this has been incorporated in the Asbestos Information Association recommended method, is the use of the Walton/Beckett graticule. Because in the U.S. method, the NIOSH method, in the British method before that, all the little graticule, little reticule, which was in the eyepiece on the microscope which was used for counting of particles just consisted of spheres and a series of lines and squares drawn on.

For the first time, a graticule was devised which was really for measuring fibers, and this is an example, this is the Walton/Beckett graticule. You can see that it is made in such a way that it has to be ordered to fit your microscope.

Now, this is a rather different move from what existed before. Normally you bought a graticule, then you calibrated the sizes in the microscope.

Now, you are really interested for counting fibers, and fibers that are greater than five microns, so there is no point in calibrating the five micron line on there and making it six microns, because now you are counting the wrong thing.

So the graticule is bought to fit your microscope, armed with all the information about magnification and so on, to be able to buy the right one.

It also overcomes a number of the other counting problems. I just thought you might like to see what it looked like.

Can I have the next slide, please?

DR. UFFEN: Is that...that's not yet required, though?

THE WITNESS: Not in the NIOSH method, as I understand it, as it exists at the moment, or in the other

THE WITNESS: (cont'd.) legislated methods.

The Asbestos Information Association had recommended that method, and I know...I don't know whether Britain have yet stipulated they would have it in. Certainly there was a lot of...all the government people in Britain felt it was a very sensible move to use such a thing. Yes.

DR. UFFEN: Do you think we should?

THE WITNESS: Yes, I would think...it's designed to count fibers. It's not designed to count particles, and all the other ones were designed originally to count particles.

Okay. The other area I was going to talk a little bit about is the...could you put it off for a second...this question of transmission EM, scanning EM and optical measurements.

In the industrial setting, largely all measurements have been made using the optical microscope for fiber counting on membrane filters. In the general environment, the dimensions of fibers generally present in community air have been such that you could not see them on the optical microscope. They would be of such a size that they would just be rendered invisible by optical observation, light optical observation.

So transmission and scanning electron microscopy have been applied to collection and measurement of such fibers.

From the general environmental measurement standpoint, there was a meeting in Germany...no, actually it was in Germany or Nice a couple of years ago, and...by the International Asbestos Association...and they brought together scientists from different parts of the world to discuss how one should measure airborne fibers in the general environment.

At that meeting there was almost a split right down the middle of the road between scanning electron microscopy and transmission electron microscopy.

Now, the split was really sort of artificial in

THE WITNESS: (cont'd.) the sense that everybody recognized if you wanted to see everything that was there then you really should go with transmission electron microscopy.

Now, the transmission electron microscopy method permitted you to collect an airborne sample, and techniques exist to be able to transfer it quantitatively to stubs for measurement. You have some practical difficulties with some of the stubs because the way in which the length of a fiber is measured, in the transmission electron microscopy the beam has to go through the hole in the grid.

If the grid hole is sufficiently small, the fiber lies across the margins of the grid and so in this area you don't see the fibers. So you can...you are limited by the length of the fiber you might be able to look at.

That increasingly can be overcome now because you have combined scanning and transmission electron microscopes and you have the ability to look across the surface of the grid as well as through the grid.

On the scanning EM side of the room were the practicalities. It is possible to buy a scanning electron microscope for considerably less than buying a transmission electron microscope.

It is much quicker to prepare a sample for scanning electron microscopy than it is to prepare one for transmission work.

Some rather elegant techniques for preparation and collection of airborne ambient fibers were produced by some researchers in Germany, whereby an airborne sample might be collected on a filter coated with gold, ashed in such a way that you didn't have to disrupt the air sample at all, and it was let in situ on your filter, on your removed filter, to be able to transfer it directly to electron microscope in a form that it

THE WITNESS: (cont'd.) existed in the air.

That sounded a highly desirable thing to do.

The limitations, though, on the TEM, we have found, have been in collecting airborne samples, the use of the nucleipore filter which has holes straight through it means that the air velocity entering the filter must be such that the fibers don't pass right through. The nucleipore filters - these are the filters with the little holes directly through them - tend also to get charged with static electricity very easily, and you have difficulties in handling them.

In addition, when you come to the measurement with the scanning EM, you have to put a coating on the fibers and sometimes a carbon coating may not be adequate and you have to go to some metal coating. This enlarges the size of the fiber, and if you are dealing with very narrow fibers it's possible that you might lose them in the coating.

So there are a number of serious technical problems on the scanning EM, from counting everything.

But if one wanted an indicator of whether...what's in the air, the scanning electron microscope provides a rapid, quick, fairly, relatively...everything's relative...less expensive method than using the transmission EM.

So if one wanted to measure everything, one would go with the transmission EM and probably today one would go with a combined transmission scanning electron microscope, which gives you the best of both worlds, and sometimes you can find a fiber with another fiber resting on top of it so you can actually see even around the fiber.

So the cost though, and the practical limitations of applying those on a routine basis, as we stand at the moment, are such that I don't think one would ever seriously consider saying the transmission electron microscopy should be a routine

THE WITNESS: (cont'd.) method for measurement in industry.

If one looks at the total volume of data available on ambient air fiber concentrations, recognizing that there have been several governments involved in making airborne ambient air concentration measurements...the State of Connecticut, for example, did measurements...the EPA have done many measurements in ambient air...if you look at the total volume of measurements that exist, they really are very, very small in comparison to the total number of membrane filter fiber counts that have been done in industry.

So from a practical standpoint there is a real limitation on how much you can do.

MR. LASKIN: Q. If you are in a jurisdiction which has different standards for different fiber types, and then you find yourself in an occupational setting where the particular employer is using more than one fiber type, can you measure in any reliable way so that you are getting counts that will reflect the different standard types?

THE WITNESS: A. It's a very difficult question. Because this problem exists not only with different fiber types, it exists, for example, within textile plants where you might have nylon fibers, you might have rayon fibers, you might have cotton dust mixed in, you might have other fibers present.

Some attempts have been done by some laboratories to, by using standard samples of these, to take a look at that and say this is what cotton looks like under this thing and so on, this is how we are going to count it.

There are methods available, and I'm not sure whether they have been done on membrane filters, but there are methods available known as dispersion staining, which permit you to look at different fibers and differentiate them optically,

THE WITNESS:(cont'd.) using their ability to be visible with different mounting media.

I think that in this regard the British government approaches to that problem might be well worth looking at, because they have had different standards for some time, and the BOHS original recommended standard was to do that.

In practical terms, it's very, very difficult for a technician to be able to identify individual fibers and to do it on a routine basis.

Now, if you were putting them into a laboratory where you have a mineralogist who is going to look at them, he can look at the different mineralogical characteristics of the fibers and probably get them right.

To make it a routine to differentiate between whether you've got a mixture here of crocidolite fiber, and amosite fiber, and anthophyllite fibers and cottons, chrysotile, in there, would not be easy to do.

Q. If you use the membrane filter method alone, do you have any judgement as to whether you can do it? It seems to me what you may be suggesting is that you are going to end up regulating to the lowest standard or the strictest standard.

A. No, I think that you can...it's a question of who you are asking to do it. If you are asking a mineralogist to do it, yes, he could do it for you. But if you were asking a technician to do it on a routine basis, they would have great difficulty.

Now, again, you may approach it by setting up certain guidelines for how they do it, and to get reproducability. That's the same way as we have done it for counting, just counting fibers in general....to have a set of rules that are applied on how people count these things.

Q. Would the scanning or the transmission

Q. (cont'd.) electron microscope have any role to play in that?

A. It's possible that the scanning...we come back to this question of can one automate counting...if one is dealing with straight amphibole in an amphibole industry, using crocidolite or amosite, the techniques for automation are far simpler because you are dealing essentially with straight fibers.

There are some deviations in straightness, but you can automate a count much more easily that way.

Now, in addition to that, if you did them on scanning electron microscope for doing such a count, then you could possibly have analyses done on certain fibers to tell you what the situation is.

The other way to do it is back to the sort of suggestion that was made earlier. It's for a general, say a particular operation where they are making pipe. Normally they are starting with a certain amount of crocidolite, a certain amount of chrysotile, and whatever...once a number of samples have been randomly taken over a period of time in that air, with the proportion of the airborne fibers which are crocidolite and amosite or chrysotile, which might be analyzed in a sophisticated laboratory, you could take your total airborne dust sample and say, well, twenty percent of that airborne is crocidolite and thirty percent is chrysotile, and the rest is amosite.

That would mean some periodic examination of airborne samples just to guarantee that things have not changed drastically over time.

That would be another approach to it if you wanted to button it down.

MR. LASKIN: Thanks, Dr. Gibbs.

THE WITNESS: The next area I was going to talk about is the pleural calcification, because I was involved in a

THE WITNESS: (cont'd.) study in Quebec, perhaps seven or eight years ago now, which was initiated because Dr. Cartier was then the doctor at the clinic in Thetford Mines, and studies of x-ray changes in the Quebec asbestos miners had indicated that there was far more pleural calcification in the Thetford Mines area than in the Asbestos area. The differences were quite marked.

The question came up, was...what could explain this? Was it the fact that the fiber was different in the two areas, or what other factors might be involved in explaining pleural calcification?

The reason that this was important is that we find with asbestos the pleurae tends to get involved far too often. We have pleural mesothelioma, we have pleural thickening, pleural fibrosis, we have calcification occurring on the pleurae, and one question that arose is if somebody gets pleural calcification are they going to get mesothelioma? Is the calcification a protective mechanism, that somebody would get calcification, hence they don't get mesothelioma? Or can you get mesothelioma as well as calcification? Is it an indicator, an early indicator, or something, that we are going to get some problems later?

What I did...can I have the next slide...I took... at that time there were five hundred and twenty...you can see here the opacities and if you take the lefthand side of the screen there you can see the opacities outlined quite clearly in the lung, due to the calcification of the pleurae.

On the x-rays, some people...and in autopsy... some people had significant layers of pleural calcification, quite large plaques and very, very thick layers of calcium phosphate on the pleurae.

Now, what I did was to take the five hundred... I think it's five hundred and twenty...cases of people out of

THE WITNESS: (contd.) fifteen thousand, six hundred and eighty some-odd x-rays which were read, of people - all miners who had worked in the Quebec asbestos mines until 1966.

Now, as x-rays began in 1935 in Asbestos and the mid-1940's at Thetford, we obviously didn't have x-rays for people which went way back to the start of the mining industry, because there could have been some people missed in between.

Nevertheless, there were some fifteen thousand or so x-rays available. These were read by a panel of radiologists, and if any radiologist had..x-ray reader...if any x-ray reader had said, this man has pleural calcification, I took his x-ray out, and we had five hundred and twenty of those.

I then got two of the readers together and I individually asked them to classify those films as to definitely positive or definitely absent, or doubtful. Never again will I use the doubtful category. I will make them make the decision.

But they did this, and we ended up with two hundred and seven people who they said, this is definitely pleural calcification, and they served as my study group.

The doubtful group proved to be quite interesting in some respects because it does...poses a question. They also raise the issue about the interpretation of other findings in the literature.

In my doubtful group...this is a group of people who they felt maybe had pleural calcification but they weren't quite sure...I think there were some fifty-odd in one group.

We found that there were two mesotheliomas, two people who subsequently got mesothelioma.

In the calcification group, we didn't have any mesotheliomas. Only in that doubtful group.

The question that came up, were they reading early changes in these x-rays which later became mesothelioma - was one

THE WITNESS: (cont'd.) possibility - were there some features of those films that might be indicative of mesothelioma later.

Now, the reason that becomes important, because in other studies there has been a report by Edge, originally, a number of years ago - I guess 1973, 1974 - that pleural calcification was also linked with mesothelioma.

Now, it might be that it depends on the degree of pleural thickening and the point at which calcification is beginning to occur, and it may be that in that group that he was calling pleural calcification he was beginning to see some of these changes our people were calling 'doubtful'.

So one has to be very careful about the interpretation of associations between certain of the pleural changes and some of the malignancies, because, as with mesothelioma, we are talking for mesothelioma perhaps twenty to forty years from first exposure, normally, maybe even more to see the mesothelioma. In pleural calcification, we found the mean years from first exposure were somewhere around twenty-eight or thirty years to see pleural calcification.

So we have people who are going to be similar age, similar periods of employment in the industry, similar periods from first exposure, and then we are going to look at their x-ray and we may end up reading one thing in parallel with the other, and drawing the wrong conclusions. So one has to be very careful about that.

Can I have the next slide? Can I have the next?

This is just to show the Eastern Townships of Quebec. It's a geological map, but it shows Thetford...you can see Thetford Mines up here. Down the other end, just off the screen to the left, is Asbestos. It's around fifty miles between them. Black Lake is just outside Thetford there. The other

THE WITNESS: (cont'd.) mining area...if we can move off that way now...is East Broughton, and that's up the righthand side of the map.

So the asbestos ore body, if you like, occurs in that strip along there, with East Broughton out this end, Thetford, Black Lake and Asbestos being the major mining areas.

Can I have the next slide, please?

Now, I've got, first, before I show you that one...this is in publication on pleural calcification.

Now, what I did was to take the two hundred and ninety-two cases altogether in the Townships, that I considered at this point for pleural calcification. I looked, determined for the whole of the Eastern Townships region...that's all the mining industry...their age, the rate of pleural calcification by age for the whole area.

Then I applied those rates to the age distribution of employees in each location within both cohorts, to determine whether or not we were seeing any higher frequency of pleural calcification in any one particular area, and you can see at the bottom here if I look overall...if I can get that clearer...if I look overall we can see that in the area A, I saw only two cases of pleural calcification. This is the area at Asbestos.

Yet I expected about eighty-six, eighty-five. So I had an enormous deficit of mesotheliomas at that area.

In area A, I also had a deficit.

But in area C, I had about two and a half times as many as I would expect. I saw thirty-three, and I expected thirteen.

If I move up to J, I saw a hundred and twenty and I expected only thirty-five.

Now, I broke the area originally into these geographical distributions and if one then put these areas

THE WITNESS: (cont'd.) together, what one found is that almost all the pleural calcification...not all of it, but most of the pleural calcification in the Thetford area...was coming from three mines right in the center of Thetford - three adjoining mines which had mined essentially the same ore body or neighboring ore bodies.

We could move just half a mile down the road and we would find that mine having about its expected rate or less than its expected rate of pleural calcification.

So here was evidence of a pleural calcification being fairly common in one small group of mines, and yet everybody was exposed to asbestos, chrysotile asbestos.

The question then came up, were there any other factors that might be responsible for the pleural calcification, are we really looking at an effect of asbestos.

Can we have the next slide, please?

This slide shows you that within those locations, J, L and there's another one, which were close together, these are the mining operations that operated in those areas, and you can see that the observed-to-expected in some of those areas are quite, quite large.

So what I did was to take a series of case control studies, then to determine if there was any indication that other factors might be important, and I found that the frequency of tuberculosis, of course, was an obvious one, where there was...was there more tuberculosis in the one group than the other. Tuberculosis differences were not enough to explain any calcification difference.

None of the medical history explained what we, the pleural calcification being higher in this area.

We looked at residences. We found no evidence from residences.

THE WITNESS: (cont'd.) We looked at a variety of other factors that might possibly be explanations, and they turned out not to be.

So what we were back to is, maybe it's something within the mine.

When we looked with the occupational distribution within the mine, we tended to find a higher frequency of pleural calcification occurring in people who had worked more frequently in the mining operations than in the milling operations.

That was interesting in the sense that it suggested that maybe it was something that the miners were exposed to, but the millers were not.

The other thing we did find was a certain amount of clumping in periods of time. Now, the numbers always became very, very small, but there was some tendency for some clumping in the mid-1920's, and this became interesting when people who had worked only a short time in the industry had worked in the mines at that particular point in time and then turned up later with pleural calcification.

What it suggests to us is the possibility that at some time or other these people had worked through some ore body or through some ore body which had been a factor in the production of pleural calcification, that these exposures possibly do occur in some of the other mines at different points in time, and that we are not necessarily looking at the pure effects of the chrysotile fiber itself.

The other possibility is that there are differences between the fibers, that we have not yet identified, that are the important factor in producing this, and that it was related to the changes in the type of work which miners did in the past compared with what they do now that might have given them a higher fiber exposure in the mine than the millers way back at

THE WITNESS: (cont'd.) the beginning of the century.

So here we have an indication the pleural calcification may not always be due to the chrysotile or to the asbestos exposure alone. Most certainly there seems to be a big difference between Thetford and Asbestos. We don't know what that is.

I have not looked recently, but I think it is something that is worth looking at - is when I first did this study, the frequency of mesothelioma in Asbestos, in people working in Asbestos Mine, was about the same as people working in the Thetford area. The cases were about split equally between the two, and at that point I had much more calcification in Thetford than at Asbestos, and this information, evidence, combined with the Finnish observation of a high rate of pleural calcification in Finnish miners, but no mesothelioma, rather suggested that pleural calcification was a totally different entity, was not related in any way to mesothelioma production.

I think it would be worth looking to see whether that distribution still holds today. I have not done that.

I'm sorry, you had a question?

DR. DUPRE: Dr. Uffen?

DR. UFFEN: Well, I just...I'll put it this way to make sure I understand what you just said...that in these abnormal places in the past, the same mining operations might have produced either a different size distribution of fibers, or the men working there may have got a much larger dose doing the same job, as in some other mine. Is it as simple as that?

THE WITNESS: No, it's not quite as simple as that. In some of the analyses I did when I looked at this, I looked at dose differences based on our impinger data. I had assessed for every worker in the industry some index of exposure,

THE WITNESS: (cont'd.) and that information existed for this group.

So it was not a total dust, if you like, exposure difference that was quantitative that was explaining it and in fact what you find is, if you look at the onset of x-ray changes in relation to dust, you find that the level of dust exposure accumulated up to about age forty-five, fifty, is important, but after that it makes no contribution to the calcification occurrence.

This is work that Rossiter did before, looking to see how dust related to rate and logical outcome.

But total dust doesn't alone explain it. There is something...there is probably something else there. It may be quantity of that that is important, or quantity of some particular...

DR. UFFEN: I'm going to suggest that these people all had different smoking habits.

THE WITNESS: Yes, smoking was something which I didn't have data on. Nevertheless, I don't know of any other data that suggests that smoking is responsible for pleural calcification.

Okay? Thank you.

The other area that I was going to address quite briefly is the question of other fibers than asbestos. The evidence from Turkey that mesothelial tumors were occurring in certain villages where the mineral erionite, which is a fibrous zeolite, was occurring of course raise the issue whether in man, for the first time, one might be seeing an increased risk of mesothelioma related to a nonasbestos fiber.

In animals, there have been a number of fibers tested and shown to produce mesotheliomas. I think there is a study by Wagner, who lists several fibers, aluminous silicate fibers, and I think brucite, nemolite, was used in some studies

THE WITNESS: (contd.) there that produced mesotheliomas, so in animals it wasn't new, and we knew that from Stanton's work we could do it with glass fibers and so on.

But in man, this evidence or information, which is still under investigation, it is still not absolutely sure that it's the zeolite that's doing it, but it's possible, raises the question of whether there are other fibers to which people are exposed.

There is a report which is with the Quebec...it was the Bureau de l'Amiante...which has photographs in it of some thirty or so fibers which were examined in our laboratories.

Now, these fibers were not identified, were compiled as a result of asking a number of people to list what fibers do you think we might encounter somewhere in mining operations or in manufacturing operations.

There are lists which number well over hundreds of fibers which can be encountered either in natural state or in industry, and I just thought that it would be worth running through a few pictures of what some of these fibers look like on the optical microscope and look like on the electron microscope.

Unfortunately, on this series of slides there are no dimensional markers. In the paper report I refer to, some of the dimensions of these fibers are given. It's very, very dangerous to sort of say, well, the size is this, because normally fibers are in a wide range, and if we look at some of the synthetic glass fibers they can have, from the blown-fiber technique, they can have tails which go down to very, very fine fibers. But if you look at the bulk of the fibers, we would say they are fairly fat fibers.

So if we could just maybe run through them.

Okay. This is a picture of what a chrysotile fiber looks like on the optical microscope. I'm not sure what

THE WITNESS: (cont'd.) the straight fiber there on the left is, but this is a fiber taken...a long, curly fiber... the sort of fiber that you were asking about that would not penetrate very deeply into the lung because its cross-sectional area would be very large and it would not penetrate.

Can I have the next slide, please?

This is a picture of some mineral wool, on the optical microscope, and perhaps...you get a feeling that if you saw that side-by-side with a chrysotile fiber you might be able to say, well, it tends to have a slightly different appearance, maybe I could differentiate it if I had to separate the two.

But let us move on to the next one, please. This is a mineral called pectolite, which you can see again is fibrous in appearance on the optical microscope.

Another one, please?

This is a synthetic material called Fiberfrax, a manmade fiber.

The next, please?

This is a sample of aloesite. You can see this material, of course, was of some interest because structurally it's very similar to chrysotile. It has a hollow hole...it has a hole down the middle. It's a coiled fiber and it was thought maybe it would, the sample would show some nice fibers.

Nevertheless, this is what we saw in the optical microscope.

Let's have the next slide, please.

This is a picture of some erionite...sorry, this is mineral wool again, a synthetic fiber.

Can I have the next slide, please?

This is a picture of erionite. This is the material...this particular sample is not from Turkey...but it's a sample of some of the fibers that are being suspected as being

THE WITNESS: (cont'd.) responsible for mesothelioma in the Turkish villages.

Can I have the next slide, please?

Okay. This is a picture, an electron microscope picture, of aloesite, the one we saw earlier, and you can see that the fibers we are talking about are very, very short, stumpy fibers on the EM, and on the optical microscope we really didn't see them.

Can I have the next slide, please?

This is a picture of erionite on the electron microscope, and you can see again the fibers perhaps in the preparation stage, the preparation for making those slides, because these are all from bulk material, some grinding or breaking up of the fiber has occurred. But there are some fibers present in that sample.

Could I have the next slide, please?

This is another picture, electron microscopic picture, of the pectolite I showed you earlier.

Next one, please.

This is chrysotile again. This is the sort of picture you see on the front of...it's from bulk material...sort of picture you see on the front of the IARC monograph of the UICC chrysotile.

Next slide, please.

This is a sample of brucite or nemolite, the magnesium hydroxide you see on...as seen on the electron microscope.

Thank you.

That picture you have just seen shows you the holes through a nucleipore filter. This is what a nucleipore filter looks like.

Thank you.

THE WITNESS: (cont'd.) The reason for showing that sort of list of fibers really is to illustrate that there are a large number of fibers that do exist - some of them naturally occurring, some of them manmade - which are definitely confusable under optical observation with asbestos, where one would like to have much more information about the dimensions of these fibers from the standpoint of respirability, from a standpoint of evaluating their potential to be a problem in terms of mesothelioma or other health risks down the way, and the data that are available to date are not that many.

Many lists have been drawn up and one of the things that might well now be initiated...in fact at the IARC meeting in Lyon a couple of years ago, it was decided that an attempt would be made to put together a sort of international inventory of fibers, and the idea was that some of those fibers might be well characterized so they could be used in experimental animal systems to determine whether fibers of totally different chemistry, given the size distributions that exist for those fibers, would produce the same types of health effects as we have been observing, effects in animals, as we have been observing with the asbestos fibers,

Part of the work that we had done in looking at these samples was related to some work going on at the University of Sherbrooke in that a series of samples of fibers of different mineralogy, with dimensions less...shorter than five microns and greater than twenty microns...would be put into cell systems to see whether or not they had effect on the macrophage or where or not any of the cytological effects observed for different fibers, fibers of different mineralogy and of the same sizes, were the same as we were observing for asbestos.

So there is some work going on in the world with an attempt to look at whether or not some of these other nonasbestos

THE WITNESS: (cont'd.) fibers present a problem.

Obviously that's very relevant in the decisions about substitution, because when one goes for substitution one very often looks for something which is very similar to the starting material, especially dimensions are very often linked to strength and so you would tend to look for something that might have certain characteristics very similar to the starting material.

Thank you.

I might add perhaps one other point which is perhaps opinion at this point, rather than provision of scientific facts.

One of the things which I think is lacking which I think should have been introduced quite a number of years ago is the systematic medical environmental surveillance within the industries handling asbestos.

Now, the reason I say that is that industries have had for many years medical departments, and industries have made measurements over the years. If they had not made those measurements, and in some cases they had no legislation requiring them to do so, if they had not done those measurements we would have had no idea of the order of magnitude of the health risks in relation to any dose at all.

Measurements of the environment cannot reasonably be done by government inspectors going in and making measurements on an ongoing basis, because no province or country can afford to have enough inspectors to randomly sample all the locations that exist in such operations.

So one ultimately comes back, from the standpoint of health monitoring, to have the industry make the measurements.

At the same time, it's important that when those measurements are made they are made in a way that they address this question of the objective being to evaluate whether health

THE WITNESS: (cont'd.) are related to them.

In other words, are we preventing health effects by lowering the level of dustiness.

What I would have liked to have seen, and I think it's essential in the future, is that the measurements in the industry are linked with the exposure of an individual, is linked with that individual at the time that the measurements are actually made.

This is very difficult for...to reconstruct ten, twenty, thirty, forty, fifty years later the information about an individual's exposure, and very often, because it's not set up to do it this way, the information that is needed to reconstruct that doesn't exist in the future.

Now, the reason I think this is important, if it had been done say in 1960, in 1980 we would have been able to say the level of exposure for the employees has dropped this amount and the frequency of radiological changes in those employees is such-and-such.

In terms of asbestosis, we would be saying well, we know where we are, we now have some information to show what the effect of introduction of dust controls has had for the worker. We would have an objective way of doing it.

What I'm worried about is that we may be back with another commission in twenty or thirty years time, saying I wonder where the data are to be able to set some dose-response curves. I think that it's something that has to be not only thought about, but I think that some guidance and some help in introducing such surveillance programs is certainly needed if... I think, from the industry's standpoint, and from the workers' standpoint and the government's standpoint down the way they may have spent a lot of money and they won't know whether or not it has done any good, and they will be back with other questions.

MR. LASKIN: Q. Can I just ask you two questions and then I'll turn you over to my friends.

One of the things, Dr. Gibbs, that I asked if you would be kind enough to do was to read one or both of Dr. Finkelstein's papers for us and give us any comments on those papers that you have, and I gather that you have looked reasonably closely at the mortality paper?

THE WITNESS: A. Yes. I did read both, but the radiological one, the asbestosis paper, I read some time ago and I'm not refreshed on it.

But I did have some comments and observations on the Finkelstein paper, which I hope will be of some help.

Some of them really were related to questions rather than answers, based on the Finkelstein paper.

One of the observations that I thought was quite an important one in the Finkelstein material was the observation that his mesotheliomas, of his ten mesotheliomas I think it was, he had six which were peritoneal in origin.

Now, if one looks at the frequency of mesothelial tumors in the Quebec chrysotile miners, I think they are essentially all pleural. And if one looks at other chrysotile-exposed groups, pure chrysotile-exposed groups, you don't very often see the peritoneal type of mesothelioma.

If you look at the New York insulation workers, who were probably mixed exposure with amosite and chrysotile - we don't know about crocidolite...or the South African series of mesotheliomas, or the gas mask workers, you do find the peritoneal mesothelioma being much more common.

I just comment on that because maybe it's support for the possibility that some of these mesotheliomas you are seeing are coming from the fact that they had a mixed exposure or they had an exposure to the amphibole variety of

A. (cont'd.) asbestos, and this plant did use mixed fiber types and one of the things that I would have liked to have known, on page eight of his report...I don't know whether you have copies of the report there...it said, "All of the men dying of mesothelioma were exposed to both chrysotile and crocidolite in the pipe plant".

Earlier in the report he says that there was a board area in the plant where they used only chrysotile, and I would have been interested if they had seen any mesotheliomas in that chrysotile population.

One has to recognize that in any plant where you have mixed fibers, it is very difficult to isolate one particular area from another area. But I think that the opportunity might exist in that group to really look at some risks within relation to different fiber types, and I think that's important not to conclude that overall that all the fibers are equally responsible for what you are seeing, if there is an opportunity to conclude otherwise.

DR. MUSTARD: Can I ask a question?

MR. LASKIN: Sure.

DR. MUSTARD: In trying to sort out mesotheliomas of the lung and mesotheliomas of the peritoneum, one is faced with a thing I seldom hear any reference to, and that is the question of inhalation of fibers versus ingestion of fibers.

Have any of you done a careful examination of the conditions in the plants in relation to there being circumstances where workers, maybe during lunch breaks or other things, could indeed...circumstances where they were ingesting fibers rather than inhaling them and having them drifting down back through the gastrointestinal tract?

Because it seems to me from my background that the important question here is not so much the fiber type as the

DR. MUSTARD: (cont'd.) question of different methods of ingestment of the fibers, or inhalation of the fibers.

THE WITNESS: I think if one is talking about total dose to the gut...

DR. MUSTARD: I guess the question is whether there are any studies, had anybody looked at the circumstances where the work conditions may have been such that the capacity to ingest the fibers was for some reason, perhaps because of eating arrangements or things like that...

THE WITNESS: Well, the major...you ask an interesting question from two standpoints, and there has been argument about whether fibers which get into the lung initially and then are brought up by the macrophages and ingested are the same as fibers which might occur in water and be ingested that way.

Now, if one...let's assume to start with there is no difference, that the lung has not in that period of deposition and first removal, the lung has not modified them. Then the total dose to the gut by just airborne exposure to fibers is considerably more than workers would get by drinking water containing fibers, for example.

DR. MUSTARD: I was thinking more of contamination of foodstuffs, because of plant conditions where you are eating.

I gather it has not been done, but I don't think...

THE WITNESS: I would think today it is far less likely. Whether or not it would have been a factor in the past, I don't know.

DR. MUSTARD: Certainly the stories we've heard, some suspicions have been raised.

MR. LASKIN: Q. Is there a current hypothesis that seeks to explain why crocidolite or the amphiboles more often

Q. (cont'd.) cause peritoneal than pleural mesothelioma?

THE WITNESS: A. I don't know. I don't know why it would be. There are various views as to how...I don't know whether there is a true mechanism.

There was one other thing that I thought was worth noting. I looked at the paper, first of all, from the standpoint of not how, the methodology in the study, but whether or not one would change the pattern by...if one were to do an analysis on the data in any different way.

There was...in other words, one doesn't change the number of mesotheliomas no matter how you design the study, and your total number doesn't change.

The same is true of the asbestosis in this group, and one of the things that I think is remarkable is that, based on your Compensation Act, presumably in Ontario, about...it says, one-third, that's twenty-nine percent, of this group had been compensated for asbestosis.

Now, then I look at the sort of levels of dustiness that...we are talking about cumulative dustiness... and that bothers me. It bothers me because of two reasons. One, I don't know what your Compensation Board requires to call a case an asbestosis, but secondly, because to have thirty percent of your...close to thirty percent of the population with certifiable asbestosis, when your maximum category of dust exposure, the majority of your workers were said to be somewhere below two hundred fiber years per c.c., that would be somebody working for twenty years at ten fibers per c.c.

Now, if we look at our Quebec mines and mills, people would have had exposures which are considerably greater than that, and yet I'm pretty sure that our x-ray changes wouldn't have shown that sort of degree of change to make them

A. (cont'd.) compensable. So either the definition of what is called asbestosis, or the dose or the mixed-fiber exposure is giving rise for that measure to different risks.

This question is always being asked, does crocidolite produce the same dose, the same rate of asbestosis as amosite and chrysotile. I don't know the answer. I'm not saying that anything is wrong. I just thought that this group does seem to have a pretty high rate of compensable asbestosis for the sort of levels of exposure that are mentioned in this particular report.

Now, if I interpret it correctly...

DR. DUPRE: Can you think of a study, Dr. Gibbs, that ever did suggest any linkage between asbestosis and asbestos fiber types? I can't think of one offhand.

THE WITNESS: No. I think all varieties of asbestos are known to cause asbestosis. There is no doubt about that.

Whether or not...we come back to this old question of how the dose is measured and whether you can compare the dose in one place with another.

You have good evidence...

DR. UFFEN: What you are telling us is that it was very high, and you are surprised?

THE WITNESS: I am surprised, that's right.

The other comment I would make is that I think he has done a lot of work on his dust information, on relatively not large quantity of dust information, and I think that he points out himself that he is worried about...not that he is worried, but he says 'I am playing with my data to get an index of exposure, I have limited data', and he cautions against that.

I think that it's important to realize in

THE WITNESS: (contd.) interpreting what he says at the end, to remember that he also is cautioning against the use, the sort of conclusions based on the very limited data on dust.

But I was amazed, really, by his rather beautiful mesothelioma dose-response curve, because I have not seen one as good as that anywhere, before. That is rather interesting.

DR. UFFEN: When you say as good as that, you mean as precise?

THE WITNESS: Well, let's see, he has three points, and almost all three points are on the line. The middle one is not far off. Now, there are only three points and...

DR. UFFEN: Cross circles, curves, straight lines, quadratic, hyperbola...

THE WITNESS: Well, if the three points were in a straight line, it's difficult to justify deviating from the straight line, and he has something very close to that there.

MR. LASKIN: Q. The only other study perhaps I could ask you about is the other recent major study that we have to deal with, and that's Dement's study.

Can you offer us any assistance in evaluating that work, other than what you have already told us last day?

THE WITNESS: A. I don't think there is a lot I can add to what we mentioned last time. I think the things that needed clarifying: one, is whether from the epidemiological standpoint, how many of his people have worked elsewhere in the marine area. I think that's an important question.

I think the question of the way in which he derived his conversion is possibly something one could look at.

Again, I think I expressed the view last time, I didn't think that even if one played around one was going to get a much different...the sort of conversions we saw last time

A. (cont'd.) when we looked at some of the data I had for textile plants were a bit higher than the values that he had given.

The data by Ayer and Lynch, published a few years ago, suggested a higher conversion factor.

If one were to combine say some of his people having had some previous exposure outside, the fact that maybe a conversion factor might have been a bit higher, that some other interactions occur, maybe that might explain it. But I don't think...it's not quite fair to sort of take the data and say, let's see how we can make it fit elsewhere.

But I think we should look at see what other explanations there might be for why it differs from other studies.

Q. The last question I wanted to ask you, Dr. Gibbs, relates in part to the study you were part of at the Homestake Gold Mine in Lead, South Dakota, as one of the things that we have also looked at is asbestiform exposure. One of the things we have been trying to do this summer is to reconcile the results of that study that you participated in, with the results of the study of the same gold mine done by the NIOSH people.

Can I ask you whether you could offer us any assistance on that issue, and secondly, whether you, yourself, have followed up on looking at asbestiform exposure in any other mining situation?

A. Okay. In relation to the first one, there have been two studies done now...three studies done on the Homestake Gold Mine.

The first two were the study in which Dement was an author, Gillam and Dement. The second was the MacDonald study, and then there was a contract awarded by NIOSH and I believe it went to the...

Q. The Stanford Research Institute.

A. The Stanford Research Institute in California.

I have not seen that report. I don't know whether it has been made public at this point in time.

The two populations that were studied by Dement and the McGill group, MacDonald and others, were different. We did not exclude anybody from exposure in the greater-than-twenty-five year...we had the quarter century club, if you want, the people with more than twenty-five years of service. We did not exclude anybody because we wanted to include people who would act, if you like, as some sort of control for the other group.

There was not doubt that pneumoconiosis was high, which is what you would predict for people who are working in gold and exposed to silica. The numbers in the NIOSH study were relatively small at the time they made their conclusions that lung cancer risk was increased.

The possibility does exist that some of the cases called tuberculosis or other causes in the past might have been lung cancer or something else. That can't be totally eliminated.

I think Allison MacDonald has done some work to try and clarify that issue.

No, I can't offer you a straight answer why in their group they found more lung cancer than they expected, and in our group we didn't. The groups were different and that might be the answer.

I think the one comment I would make is that it was not justified, in my view, for the NIOSH group to conclude that the increase of risk might be related to the short fiber, amphibole fibers present in the mine, recognizing that there are so many other factors that were not taken into account in that study. Smoking is a major factor and it wasn't taken into account.

A. (cont'd.) The occurrence of nickel and arsenic compounds...not nickel, arsenic compounds...in that mine also has to be taken into account.

So there are many other factors if one were going to argue that, yes, that is a demonstrable excess of lung cancer. But our data suggests otherwise.

Q. I take it in response to my second question you haven't been involved in...

A. No, no. But I would be very interested to see the Stanford Research Institute report, because that was set up to get a broader spectrum of employees, and it wouldn't have been limited to a twenty-five year period, so any arguments about people dropping out and not achieving twenty-five years would be eliminated.

MR. LASKIN: Thanks, Dr. Gibbs.

Mr. Chairman, we are, I suppose, in part in your hands, subject to one limitation that we have a meeting with not only the parties in the back row but all of the other parties that have been given standing, which is fixed for twelve-thirty.

Shall we commence and go until 12:20 or 12:25, or do you want to break now?

DR. DUPRE: I think we should take a break for about ten minutes, if you will, and then maybe have one of the parties cross-examine until 12:30, or...?

MR. HARDY: I don't know how much the Commissioners have to ask. We could try to finish by 12:30, and I suppose if we need an extra five or ten minutes we could probably steal it.

DR. DUPRE: Okay.

THE INQUIRY RECESSED

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THE INQUIRY RESUMED

CROSS-EXAMINATION BY M. CASGRAIN

Q. I would like to know from you what you call milling when you talk about the distinction between mining and milling?

A. Okay. I have adopted what I think is my interpretation of what the asbestos mining industry uses. The milling operation, for me, starts at the secondary crushing operation...the primary crusher being part of the mining operation, the mining of the ore, carrying it to the primary crusher, and then it's transported from there into the buildings which constitute the mill, and part of that mill is the secondary crushing operation and the separation of the fiber through to the bagging area and into the shipping.

Q. Can you distinguish between milling and the bagging area?

A. In...no. The bagging is within the mill. You are thinking of one of the papers where I talk about mining and bagging.

Q. It is a distinction?

A. Yes, because we had air samples taken specifically at a bagging operation, so I identified bagging in that instance, rather than total mill, because to work with total mill is more...

Q. So that when you were talking, during the course of your testimony, and I asked you to sort of repeat it, you were making a distinction between the length of the fiber and the cleavage of the fiber as well. You were comparing that fiber in the mining and milling as opposed to factories? Is that what you were doing?

A. That's right. Our first study..we've really

A. (cont'd.) done two studies. The first one was a very preliminary one where we used scanning electron microscopy looking at fiber sizes. We subsequently went for transmission electron microscopic observation of fibers, and we collected airborne samples of dust in...for drilling operations, for primary crushers, into the mill and around dryers, for example, and in bagging areas at fixed locations.

I was alluding to the fact that the airborne fibers collected around the bagging operation differed from those in the primary stages of production, the crushing type of operation, so that yes, there is some indication that those dimensions are different and we know that the rock is undergoing, you know, some treatment right through the mill, and we wouldn't be surprised if we had the same, probably, in the crusher as we would have in the final bagging areas.

Q. I understand.

My next question has to do with pleural plaques. I think you went rather quickly on that subject and you indicated you had made a study. I think, just for the record, not to contradict you, but I think to add, perhaps, to what you said, you did say in your study that it is highly unlikely that chrysotile asbestos itself is responsible for the pleural plaques, but rather other types of rock?

A. Yes. We could not find any explanation on the information we had at that point in time, and I guess even now, why workers exposed to what were essentially the same orders of magnitude of dust exposure in other mines in the Thetford area and Black Lake, did not have the same rates of pleural calcification as people exposed in this small group of mines, because they were both exposed to chrysotile. We discussed with people in the mining industry whether we are dealing with harsh or soft fiber, whether we had some information on trace metal

A. (cont'd.) contaminants and on other mineralogical contaminants.

We really couldn't come up with any explanation why people exposed to chrysotile in one area and chrysotile in other areas did not have the same rate. So our conclusion, based on what we had, it seemed as if something else were important.

It's possible somebody may come around the corner and say well, this parameter of chrysotile that exists in that mining area explains it. That possibility still exists, but it didn't seem that way to us.

Q. Is it true, Dr. Gibbs, that in effect if you examine x-rays of people even in remote areas from asbestos, say Montreal, you would find pleural plaques on the population in general?

A. Yes. There are some areas of the earth where pleural calcification is quite common, and in those areas in recent years attempts have been made to try and explain them in terms of some exposure. Bulgaria is one example. There, they suggested maybe sepiolite in the soil. Sepiolite can occur in a fibrous form. Maybe that's responsible.

In Finland, pleural calcification is quite high in some regions, and they attempted to explain it through the possible dispersal of anthophyllite into the air and reaching those areas.

Places like Czechoslovakia have reported high rates, and some...Navratile said he didn't have any explanation, they couldn't find what might be responsible.

Yes, there are regions where there...pleural calcification occurs and it's endemic. Nobody quite knows what causes it.

Q. My question was, would you find in the general population, you would find pleural plaques as well, in people who

Q. (cont'd.) have not been exposed to any of these?

A. Yes. That's why we looked, for example, tuberculosis, it was thought that tuberculose lesions would calcify, they might give rise to a plaque and this might be a problem. That's one of the reasons why we looked at the rate of tuberculosis in these people to see whether tuberculosis explained the risk. It did not.

M. CASGRAIN: That is all the questions I have. Thank you very much, Dr. Gibbs.

DR. DUPRE: Miss Jolley?

CROSS-EXAMINATION BY MISS JOLLEY

Q. I just have a question following the last one on calcification, and the fact that calcification can occur in the general population. It's not common, is it?

A. We don't really know the frequency in Canada. Generally, it's not common, but as I mentioned, there are some countries...and quite a number of countries now...where pleural calcification in some locations has been shown to be quite high. Finland, very widespread x-ray screening programs have been done in Finland, and the areas of high calcification mapped out.

The same was done in Bulgaria, Czechoslovakia did something like that, and I'm sure if I thought long enough I could identify some other countries.

Q. I'm a little confused, then, in your presentation of the data of the observed numbers of people with calcification over expected, and where did the expected number come from?

A. Okay. In order to get the expected there, what I said was, let's assume that all the cases of pleural calcification which come from the Eastern Townships come from

A. (cont'd.) within the mining population of the Eastern Townships and are equally distributed.

I then will expect within a certain age group a certain number, rate of people to have pleural calcification.

Now if I apply this uniform rate to each individual mine separately, I can see how many people we would have expected if calcification were uniformly distributed, and it's quite evident that it's not uniformly distributed. It's not.

I had no external rate to be able to apply. I did not know what the normal background rate of pleural calcification is in the Eastern Townships.

What I do know is that in the Thetford area there is a higher rate in certain mines and not in others.

Now, if it had been high in all of the Thetford mines, one would have been asking the question, maybe it reflects just the total community of one of those high spots in the world that has high pleural calcification.

I don't think that's the reason, but I don't know what the background rate in the whole area of Thetford is.

Q. The only other question I have is, you talked about industry being responsible for sampling asbestos and we heard from Marc Trudeau that in fact workers are involved in sampling asbestos in the Quebec mines, and I was wondering if you think that it's a good idea to have workers involved in sampling procedures?

A. I think it's important. One of the things that is important at a practical level is that the best efforts go in to measuring as objectively as possible the concentrations, and I think that workers can be trained to take samples and to do a very good job. I think that that approach is probably not a bad one in that once the credibility of the people taking

A. (cont'd.) them, in the eyes of management, is accepted, it's then straightforward for the employees and union to accept it.

That, of course, is one side of the coin, because there is obviously the day-to-day practical issue of acceptability of the measurement, and I think that the participation of the worker is very important because increasingly we want to get at what are the personal levels of exposure, rather than what are the general area levels. When we do that, we require workers to wear pumps - sometimes for several days - and if he is involved and he sees what the real outcome and importance of this is, then maybe the participation and the validity of what you get out of it becomes more important.

I know that a number of years ago that would have probably demanded a certain amount of selling to management, and I have even worked...I can remember doing some surveys myself when I was working with the Medical Research Council, an independent body, and we had some filters where a cement plant... and the workers really gave us some cement. They mixed the cement up and every now and again we would have a pump which was so solid with cement....

Now, I think that education...there is involvement, and I think those are important. So yes, when I say industry I don't mean the management only. I think that interaction is important.

MISS JOLLEY: Thank you very much, Dr. Gibbs.

DR. DUPRE: Mr. Hardy?

CROSS-EXAMINATON BY MR. HARDY

Q. Dr. Gibbs, I would like to clarify and take advantage of your knowledge of measuring asbestos in a couple of areas. First, I know you described last time you were here the

Q. (cont'd.) work you did in characterizing the exposures in the mine, and the great extent to which you worked with Mr. Lachance, who had actually made thousands of measurements in the Quebec mines.

From that work did you get any feel for the extent to which peak exposures occurred in the mines at various parts of the day, or during various operations, and similarly, the extent to which those sorts of peak exposures would ever have been measured by Mr. Lachance?

A. What we did do, we identified some of the... from his notes...some of the measurements which were related to a specific breakdown as not representative of the normal situation, and there were peaks, if you want to put it, during certain breakdowns.

I had the opportunity to observe what would have been a peak exposure for some maintenance people in the late 1960's, probably around 1967 or so. At that time, some of the mines provided compressed air hoses in the mills, and during the cleaning of motors for electrical repair work I saw some maintenance crew arrive, it was a shutdown period there, they got to work on taking the motor out, but the first thing they did was clean it and the area, and the compressed air jet went on. I can guarantee I wouldn't have seen you where you are now from where I am.

So that would have been a peak exposure, it would have been a very short period of time. But it's one of the problems, it's a very real problem, in terms of assessing those individuals, what sort of lifetime exposure those individuals get.

Some work has been undertaken in Germany on exactly that, and some of the peak exposures can be quite high

A. (cont'd.) in comparison to the mean average exposure.

Dr. Roebuck, with the asbestos cement industry in Germany, had his technicians follow workers around with instantaneous recording instruments. He wasn't measuring specifically asbestos fibers, but he was measuring dust generation at a particular point, and certainly found sometimes the peaks were quite high.

The significance of those peaks, one doesn't know. We don't know enough about just the general total dose, and we don't know whether the individual high peaks versus... many high peaks over short intervals, versus average concentrations, whether this produces a difference.

Q. Did I understand from the first part of your answer that some of Mr. Lachance's historic measurements had been at periods when these sorts of peak exposures were occurring?

A. Yes. Occasionally he had been asked to look, you know, for example they might have a breakdown of some sort and he might be asked to look at some specific area because there was a leak or something was going on which wasn't normal, and he would make a note in his book as to this is what was done.

Yes, that would give some idea. But in the early period, of course, the levels were already very, very high and I don't think...they were high as an exposure. Now it may be if one could really classify people as extremely high, where you could identify these people even in that period who had exposures which were grossly beyond that, one might be looking at very significant risks for those people in terms of...but getting at it would be, nowadays I think, almost impossible.

Q. When you characterize exposures for each

Q. (cont'd.) job and area in the mines and mills to determine cumulative exposure, did you include the numbers that you were able to identify that were generated during these peak breakdown periods?

A. No. What we looked for in the literature were those which were representative of the normal level of exposure, normal background levels in those areas.

It's possible people would have very high.

Now, the other thing one has to realize on the counter end of that, which has always been a difficulty, when one goes back in time to the forties, thirties, and so on, and even earlier, we have to realize that the separation of asbestos from the host rock is an aspiration process. The rock is passed over a screen and air is drawn off.

Now, air has to replace that air that is sucked off. That air normally comes from outside in the summer, and in the Quebec mills in the winter now a proportion of the air is recirculated for energy purposes. You get enough heat from the equipment to heat the air to keep the mill warm, so you recirculate a portion of the air after filtering it through filter bags.

If you go back in time before you had filter bags, you didn't have an easy way of recirculating that air if you had cold air.

I remember seeing one mill back in 1967, where they had very limited control and workers would run from the... when it was thirty-five degrees below zero outside, and we did some sampling in that mill and you could put your hand on the screen and your hand stuck, it was cold. Workers did not want to stay around in there.

So even if they got peak exposures, they also go periods where they would disappear into whatever little corner

A. (cont'd.) or warm spot they could get, out of the dust. And these are very real problems in assessing exposure, because in addition to knowing you have some peaks, probably, you also know you have some opportunity for some people to get away from exposure, and you don't always have information on what the levels of exposure are in those areas that they tried to get away from.

DR. UFFEN: I have a related question that might...were you able to keep records, or did they keep records of blasting procedures? They might have varied from one mine to another, and I've forgotten, were there any underground works or was it all open pit?

THE WITNESS: No, there were some underground. Underground operations went...some mines went underground for a period. For example, at Asbestos they went underground in... I may get the dates wrong, but around the mid...I think early fifties they went underground for a period of time.

Then they decided that they could no longer gain their ore through the underground efficiently, so they went back to open pit.

Some of the early operations in the Thetford area were sort of little holes into the sides of the hill, and now we have...there is the Bell Asbestos Mine, which is an underground mine, the Asbestos Corporation operate an underground mine, and some of those mines have been in operation for a long time.

The old King and Johnson Mines were underground mines for many, many years.

But as far as records were concerned on blasting, the number of underground measurements and the number of open pit measurements, measurements in the open pit were very, very sparse. It wasn't something that was done as a routine, and one of the things I think for the future is that...I'm not sure

THE WITNESS: (cont'd.) whether enough measurements are now done, even, in the open pit. A lot of emphasis goes on the mill because that's where most people are exposed to the main fiber.

But I would think the mines might have some idea on what they use for blasting and how frequently they blast, whether it be recorded or not.

DR. UFFEN: I would think it would be quite interesting and important to compare blasting procedures at different times and in different mines, because the little while that I worked underground wasn't in asbestos, but it made a whale of a difference who did the blasting, and we would be sitting in the lunchroom in the charge went off and the dust would just come down the attic and into the lunchroom, depending on whether Bill or Tom or Harry had...

THE WITNESS: Done the blasting, yes.

DR. MUSTARD: Can I ask a question about pleural plaque story that you gave us then? Those mines that you were showing in relation to pleural plaque would have been very variable, and some of them would have been underground, some of them would have been open pit. They were not all comparable operations, or were they?

THE WITNESS: No. That's right. There would have been about four or five mines or pits in the same area. There would have been three underground mines which were side by side, plus a couple of open pits. The reason that I hesitate is that the names of the mines and the companies that have owned them have changed over the years, and so they were known by different names, and some of them got amalgamated under new companies. But the ore bodies we are talking about are neighboring ore bodies, and some would...they are all in one geographic...

M. CASGRAIN: You said near Thetford, right?

THE WITNESS: That's right. They are all in the geographic...

M. CASGRAIN: You have Asbestos part of it, the National Mines and the others?

THE WITNESS: Well, National? No, National was too young to...that's right.

But it would have been a mixture of underground and open pit, but not..some of the companies, of course, operated both underground and open pit, side by side at the same time.

DR. MUSTARD: You have no way of tracking whether the pleural calcification can be in any way related to the kind of operation people worked with?

THE WITNESS: Whether it's underground or open pit? Yes, because...

DR. MUSTARD: Or kinds of blasting, even, I suppose.

THE WITNESS: No, it's very difficult. One of the things that I hoped to have been able to have done would have been to reconstruct the rock types that these people had worked through in the past. But of course when you go back...the mines have got maps of what they recovered, but when you look there you find it's asbestos and waste, right? And that's all you've got, so we don't know.

MR. HARDY: Q. You also referred early today, Dr. Gibbs, to the limitations of the midget impinger measurement technique at low levels of asbestos. Could you perhaps just explain to us the nature of those limitations?

THE WITNESS: A. Yes. First of all, the efficiency of the midget impinger for collecting asbestos fibers, we are just talking about asbestos fibers, is very low.

A. (cont'd.) So that in the asbestos mining industry in the past, and I guess in other industries, the total number of particles that were observed on them, collected in impinger, as measured at a hundred times magnification, were counted.

No real concern was given to the fact that what you were counting were not mainly asbestos fibers, they were mainly other particles, and there were problems with some of the fibers that did get trapped floating to the edges of the counting field. There were a number of practical difficulties.

The midget impinger, because it uses a liquid medium for collection, which evaporates, means that you can usually sample for only a short period of time. Normally it used to be ten minutes, possibly you might make it fifteen minutes before having to have to fill it up.

It's not very convenient for a worker to wear such a midget impinger on his belt or on his lapel, or wherever, keep in the vertical sense so that it doesn't spill - there are some spillproof types - but top it up every ten minutes or fifteen minutes for an eight hour working shift, if you wanted to take an eight hour sample.

So it's not a practical instrument for an eight hour sample of dust. It has a low efficiency for fiber collection, it is not only...it has limitations in the sense that you are only looking at particles which are fairly large, about a micron or so, because of the settling method that is defined for counting the impinger samples.

So in my view it's not an ideal instrument. If one had a choice today, one wouldn't choose the impinger as the method to measure dust. But it was used before and we have to use what method was used.

Q. Do I gather correctly that these problems with the midget impinger which you have just described are exacerbated as exposure levels go down?

A. As the exposure levels go down, you run into problems. First of all, if you can only sample for fifteen minutes and you collect a very small number of particles in that, then the number of particles you see on your microscope are low, and so your errors begin to get higher.

So, yes, you would have probably more problems at the low end, low concentrations, than you might at the higher end.

Q. One final area, let me ask you a few questions about, is the area of conversion of particle counts to fiber counts, and in particular I was curious if you had any views on the distinction between the way Dr. Dement did that conversion and the way you have done those conversions in the Quebec mines.

The distinction I am thinking of is that he determined a single conversion factor, which he then applied to almost all the jobs and areas in the plant, whereas you determined different conversion factors for different jobs and areas.

A. Without examining his data and what he started with, one can't say whether he is right or wrong to do that. What I do know is that when we looked at our data and I think when Ayer and Lynch looked at their data, they found...

Q. You mean your data on the textile plant?

A. No, our data on the mines.

Q. Okay.

A. Because I think even looking at our data on the textile plant that I would need to refresh my memory to answer that for that particular plant.

But on the mines, if one looked at the ratios one got for different mines and for different locations within

A. (cont'd.) mines, they were quite different... a big range.

Because of that and the fact that we saw very little in the way of an overall correlation between the midget impinger and the membrane filter count if one took all the samples that were taken, we didn't feel comfortable with plucking some number out of that and applying it overall.

Now, we have some problems even when you go to specific locations and recognizing the limitations of the numbers and measurements of side-by-side measurements available, you are forced into sometimes not very many measurements for a particular location.

You find perhaps a little bit more homogeneity in the ratios you are getting with that approach than you do by taking an overall figure, so that's why we chose to go that way.

So one would need to look at the Dement data to say whether his degree of variation with process is sufficiently great.

Lynch and Ayer though, did conclude that they thought no single, overall factor could be used, and...

Q. That was the study of textile...

A. That was the study of textile, yes.

MR. HARDY: I don't have any further questions, Mr. Chairman.

DR. DUPRE: Dr. Uffen? Dr. Mustard?

One question, Dr. Gibbs, bearing in mind your testimony earlier this morning on the importance of making sure that in measuring right now we should not fail to measure some things that could cause us regret fifteen years from now, bearing that point in mind, do you have an opinion on the validity, for example, of what I understand to be the German approach which combines a fiber measurement standard with a mass measurement

DR. DUPRE: (cont'd.) standard?

THE WITNESS: I would need to know whether the... we have a similar standard in Quebec, I guess, a mass and a number standard. But they are designed for different purposes.

DR. DUPRE: I am thinking of one that would be used for the same purpose.

THE WITNESS: Yes, okay. I think if one were to use it, run parallel samples, is what we are talking about, for a mass determination and for a number determination, before making the decision to go that way I think one would have to look at what practically one wishes to get out of those samples, because the decision to do that does impose a whole series of complicated parameters in the practical application. One may be back to something like we talked earlier about, that one selects certain indices or an index for use in a routine way, and superimposes upon that the need to gather certain information periodically throughout the operation to keep an eye on what is going on.

You may decide by doing it that way that the one actually adds nothing to what you've got.

For example, if you found your total airborne mass relates beautifully to your other index, you could look seriously at whether or not you needed to discontinue one or continue one or the other, in the long term.

That way you don't throw away information. You set out at the outset with clearly defined objectives and then you make rational decisions down the way.

But I think the danger about superimposing lots of different measurements on the industry and the employees to carry out, is whether or not you really will get the sort of quality data that you want in the first place.

You need to have adequate numbers of samples

THE WITNESS: (cont'd.) and representative samples, and then if you say well, we'll double that by requiring that to be done twice, the first thing that is going to be thought about is maybe we can halve the number of samples and we can cut out the...cut down the frequency and so on. So there are practical considerations.

The one other thing that I think, though, that could well be done, is an important thing to be done, is that we have tended to go about the measurement of asbestos and lots of other things in a very sort of ad hoc sort of way. We have tended to go out and measure things just because we need to have some measure of what people are exposed to at some point in time.

It seems to me that one could do a far better job, and perhaps even reduce the amount of work in the long term, by carefully designing how one is going to go about sampling different types of industry.

If, for example, one is going to make measurements in a textile industry and they have twenty workers who are working on looms, by taking a certain number of samples and looking at the variation that occurs there, one can estimate how many samples one needs to take on how many people, and how frequently over a period of time, to put certain levels of confidence, if you like, on your measurements.

Now, maybe you are going to have to accept pretty wide levels of confidence because the variation might be enormous. Nevertheless, you go into it with your eyes open in terms of what you are getting.

At the moment, what we tend to do is say well, we need to monitor the exposure of these workers so let's find a couple of workers today who will wear it, and somebody has got some time to do it.

I think that some objective proper design of

THE WITNESS: (contd.) sampling in the long term will save everybody a lot of time and effort, and give more quality, better quality data. I think that needs to be looked at quite seriously.

DR. DUPRE: Well, Dr. Gibbs, you have given us well over a day, and you've been kind enough to come twice. On behalf of all of us, may I say thank you most sincerely indeed.

THE WITNESS: Thank you.

DR. DUPRE: I take it, counsel, we are now adjourned sine die.

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THE INQUIRY ADJOURNED

THE FOREGOING WAS PREPARED
FROM THE TAPED RECORDINGS
OF THE INQUIRY PROCEEDINGS

Edwina Macht

EDWINA MACHT